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# Science & Technology

## USSR: Materials Science

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# SCIENCE & TECHNOLOGY

# USSR: MATERIALS SCIENCE

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# NATURE OF LONGITUDINAL CRACKS IN CONTINUOUSLY CAST SLABS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 12, Dec 86 (manuscript received 14 Feb 86) pp 22-26

[Article by B.P. Moiseyev, V.A. Yesaulov, V.A. Nikolayev, V.V. Yemelyanov and N.I. Gubin, Institute of Ferrous Metallurgy, Dnepropetrovsk]

[Abstract] A study of longitudinal crack in continuously cast slabs of plain carbon steels and low-alloy steels with 0.07-0.22% C was made, supplementing extensive studies already made by many researchers essentially for evaluation of this process. Specimens of St3 killed carbon steel and 17Mn1Si, 09Mn2VNb alloy steels (60 slabs from 8 ladles of each) and 09Mn2Si, 14Mn2Si, 10CrNiSiCu steels (60 slabs from 2 ladles of each), 250 mm wide and 1500-1650 mm long, were cast with the radial machine in the Azovstal plant with either water spray or water-air cooling. Subsequent structural examination revealed 200 mm long cracks on the untreated surface and 50-150 mm long cracks 4-8 mm deep below the surface in water spray cooled slabs of St3 and 17Mn1Si steels. Microstructural examination and phase analysis revealed a correlation between crack length and sulfide inclusions in the steel, longer cracks forming in steel with a higher sulfur content. Evidently sulfur stimulates formation of liquate films with eutectic composition during solidification, such a film solidifying at a lower temperature than the main steel mass so that hot cracking is likely to occur. Holding the sulfur content in steel below 0.02% and secondary water-air cooling should minimize longitudinal cracking during continuous casting. References 21: 12 Russian, 9 Western.

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DIFFUSION OF SULFUR INTO TITANIUM AND Ti ALLOYS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 12, Dec 86 (manuscript received 20 Sep 85) pp 52-55

[Article by S.V. Zemskiy and L.S. Makashova, Yaroslavl Polytechnical Institute]

[Abstract] Diffusion of sulfur into titanium and into the WTi6Si alloy with 4.5% Al and 3.5% V at $\alpha$-phase temperatures of 885-950°C was studied in an experiment with the $^{35}S$ isotope used as sulfur source so as not to exceed a 0.002% S content upon saturation. Infused and resmelted WTi6Si ingots were forged into rods 8 mm in diameter. Those were homogenized and then cut into specimens for diffusion welding either to Wti6Si specimens not containing $^{35}S$ or to specimens of iodided titanium. Welded couples were annealed at temperatures covering the 800-1000°C range, each temperature maintained within ±5°C, for periods ranging from 10 min to 1 h. The depthwise distribution of sulfur in the diffusion zone was determined on the basis of autoradiographic measurements with layerwise analysis of autoradiograms. Quantitative analysis of the data and calculations based on the applicable equation of diffusion for a nonmetallic element into a multicomponent system, in this case the Ti-Al-V system, indicate an interstitial mechanism of sulfur diffusion into titanium with a diffusion coefficient smaller than that for carbon. References 8: all Russian.

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INFORMATIONAL DIAGNOSTIC MODEL FOR CONTROL OF TECHNOLOGICAL PROCESSES IN STEEL CASTING PLANT

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 12, Dec 86 (manuscript received 4 Apr 86) pp 82-85

[Article by S.V. Knyazev and V.I. Antipenko, Ural Polytechnical Institute]

[Abstract] A control of the steel casting process has been developed on the basis of a mathematical model providing diagnostic information about all technological parameters which determine the product quality in terms of its defectiveness level, a probabilistic quantity. The control process involves statistical and correlation analysis for both qualitative and quantitative appraisal, designed so as to almost completely eliminate subjective perception as a factor. The control is organized with a computer operating in the interactive mode and includes a special sub-routine for self-adaptation on the basis of the minimum defectiveness level as the optimality criterion. References 3: all Russian.

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## RECONSTRUCTION OF MICROWAVE RADIO IMAGE IN MULTILAYER MEDIUM

Sverdlovsk DEFEKTOSKOPIYA in Russian No 12, Dec 86 (manuscript received 25 Mar 85, in final version 22 Apr 86) pp 32-37

[Article by V.L. Spivak]

[Abstract] The problem of reconstructing an image in a multilayer dielectric medium for microwave radiointroscopy is solved theoretically for the general case of an arbitrary number of layers rather than two dielectric half-spaces. Interference as well as polarization is taken into account, the latter usually carrying much information. The method is based on resolution of the radio image into a space spectrum. The algorithm consists of a Fourier transformation with a weight coefficient which accounts for the sensitivity of radio receivers, resolution of the electric field intensity into its two components respectively parallel and perpendicular to the plane of incidence, calculation of the spectrum in each layer, transformation of the spectrum for extraction of useful information, and an inverse Fourier transformation. Implemented with special processors and use of the fast Fourier transformation, this method is very practical for reconstruction of radio images in multilayer media in real time. References 6: 4 Russian, 2 Western (both in Russian translation).

2415/9716
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UDC 620.179.13

## URGENT PROBLEMS IN DEVELOPMENT OF METHODS AND EQUIPMENT FOR THERMAL NON-DESTRUCTIVE INSPECTION

Sverdlovsk DEFEKTOSKOPIYA in Russian No 12, Dec 86 (manuscript received 5 May 85, in final version 14 Oct 85) pp 48-55

[Article by N.A. Bekeshko, Scientific Research Institute of Introscopy, Moscow]

[Abstract] Thermal methods of nondestructive inspection have already been introduced in four major industries: petrochemical, electrical, engineering, radio-electronic, and construction. They contribute substantially to fuel and energy economy and their scope continues to broaden. Either metal-halide lamps or xenon flashtubes are used as heat sources, and recently lasers and electromagnetic heaters as well. Heating must sometimes be accompanied by cooling for attainment of sufficiently large temperature drops and contrasts. These methods are eminently suitable for inspection of composite materials ranging from reinforced concrete to metal-glass seals, also welded metal joints, for detection of microdefects as well as macro-defects. Both scientific and engineering research must and does continue toward improvement of thermography and active thermal defectoscopy. Essential

here is the theory of temperature distribution in defective media as a basis for solving forward and inverse problems of heat scattering by structural anomalies. It is still necessary to improve the accuracy and the reliability of physical and mathematical models. On the practical side there is a need to ensure uniform heating, higher immunity to fluctuations of heat source and object surface parameters, and high resolution for complete identification of defects including their embedment depth as well as their dimensions. The principal equipment for thermal nondestructive inspection now commercially available are thermal imagers with optomechanical scanning and liquid-nitrogen or thermo-electric cooling, variously designed for specific applications. Monolithic and discrete thermodetector arrays are now built using charge-coupled or charge-injected devices on narrow-band compound semiconductor materials (InSb, CdHgTe, SnPbTe), or using Schottky-barrier photodiodes (PtSi) with switching by charge-coupled devices. Pyroelectric converters are considered because of the high sensitivity they offer over a wide radiation spectrum, but their temperature and space resolutions are still inadequate. An important development is the sprite detector with internal integration, featuring a simple construction with relatively few contacts and a high voltage sensitivity. Another promising instrument is the vibrothermal imager. A review of trends over the 1965-84 period reveals a steady progress in terms of equipment size and weight reduction as well as better performance characteristics and capabilities. Much attention is moreover paid to computer-aided automation of equipment and procedure, including analysis of thermal images of inspection objects. References 35: 18 Russian, 17 Western (2 in Russian translation).

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UDC 620.179.14

## MAGNETIC INSPECTION BY MEASUREMENT OF DEMAGNETIZING FIELD FOR CONTROL OF HIGH-TEMPERATURE TEMPERING PROCESS

Sverdlovsk DEFEKTOSKOPIYA in Russian No 12, Dec 86 (manuscript received, in final version, 14 Apr 86) pp 60-64

[Article by I.A. Kuznetsov and V.M. Okunev, Ural State University imeni A.M. Gorkiy]

[Abstract] High-temperature tempering of two medium-carbon steels, 40Cr and 38Cr2MoAlN$_2$, was controlled experimentally by magnetic inspection, namely by measurement of their magnetic properties and the demagnetizing field. Square bars (10x10 mm$^2$ in cross-section, 66 mm long), square plates (52x52 mm$^2$ large, 5 mm thick), and cylinders (21 mm in diameter, 60 mm long) were first quenched from standard temperature and then tempered at various temperatures covering the 250-700°C range. The following were measured after this treatment and subsequent magnetization with an attachable electromagnet: the coercive force and the remanence of specimens, also the external magnetic field of the magnetometer solenoid, the tangential component of the internal field with the solenoid switched off, the demagnetizing current of the electromagnet with the internal magnetic field reduced to zero. Measurements

were made by standard procedures with a ferromagnetic probe. In the analysis of the data account was taken of the effect of an air gap between probe and steel specimen. Subsequent inspection of bolts made of 40Cr steel and tempered at temperatures from 250°C to 750°C had to take into account errors dependent on the specimen surface finish under the probe, particularly those caused by scratches made by the thread cutter as well as errors caused by the allowable variance of geometrical dimensions and especially of the diameter. References 4: all Russian.

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## STRUCTURE AND ABRASION RESISTANCE OF GALVANOPHORETIC COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 86 (manuscript received 6 May 86) pp 21-26

[Article by Yu.A. Gusliyenko, I.M. Fedorchenko and I.O. Shmatko, Institute of Materials Science Problems, UkSSR Academy of Sciences]

[Abstract] A simple technology of liquid-phase sintering has been developed for producing galvanophoretic coatings of refractory compounds, carbides and borides, but the structurization process and the feasibility of controlling it have needed further study. An experimental study was therefore made on two types of these coatings: 1) compounds ($CrB_2$, $Cr_3C_2$) with a solid phase adequately soluble in the liquid phase and wettable by the galvanic sublayer, 2) compounds ($Mo_2C$, TiC, $TiB_2$) weakly interacting with the liquid phase. Microstructural examination and microstress analysis after isothermal heat treatment at the melting point of the galvanic sublayer material have yielded the dependence of the Ni lattice period, the microstress level and relaxation rate, and the $Ni_xCr_tB_z$ nucleation rate on the length of treatment time and the ratio of phoretic layer thickness to galvanic layer thickness, formation of $C_rB_2$ with attendant appearance of a new phase $Ni_xCr_yB_z$ having been selected as a representative case. An evaluation of the results based on the applicable equation of kinetics as well as mechanical tests for microhardness of wear rate indicate the feasibility of producing such coatings with a resistance to abrasive wear 2-3 times higher than that of conventional W-Co15 coatings. References 8: all Russian.

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CSO: 1842/75

UDC 669.24.292.293.017.13

# ISOTHERMAL SECTION THROUGH CONSTITUTION DIAGRAM OF V-Nb-Ni SYSTEM AT 1050°C

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 86 (manuscript received 8 Apr 86) pp 39-44

[Article by V.N. Yeremenko, S.B. Prima, L.A. Tretyachenko and P.A. Verkhovodov, Institute of Materials Science Problems, UkSSR Academy of Sciences]

[Abstract] A study of the ternary system V-Nb-Ni at the 1050°C temperature was made, looking toward construction of its constitution diagram and corresponding isothermal section. At this temperature a $\sigma$-phase with 55-72% V, which had been formed by peritectic V-Ni reaction at 1280°C is known to exist, and a ternary Laves $\lambda_1$-phase in the $NbV_2$-$NbNi_2$ system within the 12-42% $NbNi_2$ range is known to exist at 900°C. The experiment was performed with specimens of 28, 32, 56, 75% Ni isoconcentrates and $Nb_{35}Ni_{45}$-$V_{57}Ni_{43}$, Nb-$V_{57}Ni_{43}$, V-$Nb_{50}Ni_{50}$, Ni-$V_{50}Nb_{50}$ series. The alloys were produced in an electric-arc furnace with a nonconsumable tungsten electrode, in an argon atmosphere purified by a Ti-Zr getter. The raw materials were VNM-1 thrice electric-arc resmelted vanadium, N-1 99.83% pure nickel, and zone-refined niobium, both V and Nb pretreated before addition of Ni and resmelting so as to ensure a not larger than 0.5% change in mass. Specimens were first heat treated at a temperature of 1300°C or 1200°C, depending on the solidus temperature, and then all annealed at 1050°C for 30-100 h. Microstructural examination was done under an MIM-8 optical microscope, phase analysis was done with an RKD-57 x-ray camera in a DRON-1.5 x-ray diffractometer, local x-ray spectral analysis was done with a laser x-ray spectrum analyzed as well as with "Cameca" MS-46 and "Superprobe-73" instruments. The results indicate that the ternary Laves $\lambda_1$-phase is, at 1050°C, in equilibrium with the binary phases $\mu$-NbNi, $\epsilon$-$NbNi_3$, $\sigma$-VNi as well as with $\gamma$-(Ni) and $\beta$-(Nb,V) solid solutions. In the V-Ni binary system the range of solutions containing Ni is very narrow and the solubility of Ni in alloys containing less than 80° V does not exceed 2%, but the solubility of Ni increases up to 14% as the V content exceeds 80%. References 10: 7 Russian, 3 Western (1 in Russian translation).

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ISOTHERMAL SECTION THROUGH CONSTITUTION DIAGRAM OF U-Mo-B AND U-Re-B SYSTEMS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 86 (manuscript received 17 Feb 86) pp 50-52

[Article by I.P. Valovka and Yu.B. Kuzma, Lvov University]

[Abstract] A study of the ternary systems U-Mo-B and U-Re-B was made, looking toward construction of their constitution diagrams and isothermal sections, so far only formation of borides $UMoB_4$ and $UReB_4$ with a $ThMoB_4$ structure being known. Specimens for the experiment, 48 of U-Mo-B alloys and 30 of U-Re-B alloys, were produced from Mo, Re, B powders with 99.7%, 99.98%, 99.3% compactness respectively. They were fused in an electric-arc furnace, in an atmosphere of purified argon, with a no larger than 2% loss of mass. They were homogenized by annealing at a temperature of 1000°C (U-Mo-B) or 800°C (U-Re-B) under vacuum for at least 500 h. X-ray photographs were taken with a camera 57.3 mm in diameter using a CrK-radiation source. Powders with more than 30 atom.% U were found to have been partially oxidized into $UO_2$ despite the protective layer of passive oil, solid solution in U apparently constituting the easily oxidizable phase. No significant solid solutions in binary borides were detected. A subsequent phase analysis of new borides in a DRON-3.0 x-ray diffractometer using a $CuK_o$-radiation source revealed three new borides $U_2MoB_6$ (Pbam space group, $Y_2ReB_6$ structure), $UReB_3$ ($Pb_3/mmc$ space group, original structure), $U_2ReB_6$ (Pbam space group, $Y_2ReB_6$ structure) in addition to the two already known ones. References 9: 7 Russian, 2 Western (1 in Russian translation).

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CSO: 1842/75

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CHANGE IN CHEMICAL COMPOSITION OF $\alpha$-$SiN_xH_y$ AND RED SHIFT OF ITS ABSORPTION EDGE

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 1, Jan 87 (manuscript received 27 Mar 85) pp 73-76

[Article by L.V. Khramova, T.P. Chusova, V.A. Gritsenko, G.N. Feofanov and T.P. Smirnova, Institute of Inorganic Chemistry and Institute of Semiconductor Physics, Siberian Department, USSR Academy of Sciences]

[Abstract] A study of amorphous $\alpha$-$SiN_xH_y$ layers produced from $SiH_4$ and $NH_3$ was made, for the purpose of establishing the relation between change in the chemical composition and red shift of the fundamental-band absorption edge during high-temperature annealing. Specimens of such layers were produced from a $SiH_4$:Ar:$N_2$=1:25:100 mixture at a temperature of 830°C in a low-pressure reactor. The infrared spectra were recorded by the method of multiple departures from total internal reflection, these indicating only the N-H bond. Annealing at temperatures above 700°C was found to release both nitrogen and

hydrogen from a layer, with a consequent fading of the N-H absorption line. The pressure of escaping gases was measured at a constant temperature of 850°C, a nonisothermal membrane nullmanometer being used for tracking the gas escape kinetics by series of static measurements. The experiment was performed in two stages. In the first stage the dependence of the total gas pressure on the length of annealing time was determined until the pressure ceased to increase and remained equal to the nitrogen pressure (1429.9±26.7 Pa). In the second stage nitrogen and hydrogen escaping from the solid layer were separated for a quantitative determination of each, with a Ti sponge used as getter for absorbing the hydrogen. An analysis of the results, combined with theoretical analysis of the bond and electron structure based on electron-paramagnetic-resonance data, has revealed the relation which exists between the quantity of broken =N-H bonds and the quantity of formed =Si-Si= bonds with the attendant shift of the fundamental-band absorption edge. The transformation of o $-SiN_xH_y$ evidently proceeds according to the scheme $\equiv Si > N\text{-}H \rightarrow \equiv Si\text{-}Si\equiv + \frac{1}{2}N_2 + \frac{1}{2}H_2$ with nitrogen and hydrogen escaping in equal $\equiv Si$ molar amounts. The authors thank V.A. Nadolinnyy for experimenting with electron-paramagnetic resonance in o $-SiN_xH_y$ layers, P.P. Semyannikov and V.M. Grankin for performing mass-spectrography. References 10: 5 Russian, 5 Western (1 in Russian translation).

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# ELECTRICAL CONDUCTIVITY OF $H_2V_{12-x}Mo_xO_{31+y}.nH_2O$ XEROGELS

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 1, Jan 87 (manuscript received 1 Apr 85) pp 139-141

[Article by V.L. Volkov, V.M. Bondarenko, G.S. Zakharova, R.M. Vareykene and A.A. Ivakin, Institute of Chemistry, Ural Scientific Center, USSR Academy of Sciences, Institute of Semiconductor Physics, LiSSR Academy of Sciences]

[Abstract] The electrical conductivity of xerogels of vanadic acid $H_2V_{12}O_{30.7}.8.4H_2O$ and vanadic-molybdic polyacids $H_2V_{11}MoO_{31.2}.8.4H_2O$, $H_2V_{10}Mo_2O_{31.7}.8.6H_2O$ and $H_2V_9Mo_3O_{32.3}.9.0H_2O$ was measured, the polyacids being regarded as substitutional solid solutions with Mo replacing V in vanadic acid $H_2V_{12}O_{31-y}.nH_2O$. The acids were produced by stoichiometric dissolution of chemically pure $VO_2$ and $H_2MoO_4$ in $H_2O_2$ at temperatures of 2-7°C, then heating the peroxides slowly to temperatures of 20-80°C till they decomposed into a colloidal solution which eventually gelled. Specimens of these gels, after having been dried in air at a temperature of 60°C, were examined by chemical, infrared spectral and x-radiographic methods. Infrared spectra were recorded in a UR-20 spectrophotometer with paste made of vaseline oil; x-radiograms of xerogel films were recorded in a DRON UM-1 diffractometer with a $CuK_\alpha$-radiation source. Electrical conductivity and its temperature dependence $\log \sigma = f(1/T)$ were measured on compact pellets with

direct current. Thermal differential analysis was performed in an MOM Q-1000 derivatograph with heating at a rate of 10°C/min. The electrical conductivity was found to decrease with increasing V replacement by Mo. Its temperature dependence was found to have three characteristic ranges, moderately sloping linar log $\sigma$ = f(1/T) above 400 K and below 333 K with a steep increase of electrical conductivity probably owing to compression from 333 K to 400 K in the case vanadic-molybdic polyacids, more blurred transitions from one range to another in the case of vanadic acid. References 3: all Western.

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RADIOACTIVE SURFACE CONTAMINATION OF SILICON INSIDE NUCLEAR REACTOR

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 1, Jan 87 (manuscript received 17 Apr 85) pp 152-153

[Article by T.P. Svistelnikova, V.A. Kharchenko and A.A. Stuk, Scientific Research Institute of Physical Chemistry imeni L.Ya. Karpov]

[Abstract] Surface radioactivity of silicon bombarded by thermal neutrons is more problematic than its volume radioactivity because of the longer half-life of isotopes adsorbed in the process. The surface of silicon components inside a nuclear reactor is usually decontaminated by way of deactivation, the particular technique depending on the adhesion of radioactive elements and their depth of penetration. A study of contamination and deactivation was made on up to 3 mm thick silicon single-crystal plates which had been grown by the floating-zone method, mechanically ground and chemically polished, rinsed with water, wrapped in aluminum foil, and put in quartz vacuum containers. They were then bombarded with thermal neutrons in doses of $10^{16}$-$2 \cdot 10^{19}$ n/cm$^2$ inside the water-filled experimental research channel of the VVR-Ts water-moderated water-cooled reactor. The impurity content after bombardment was determined on the basis of activation analysis and found to include corrosion products from the water, which had dissolved structural material such as stainless steel and an aluminum alloy. After a rinse in water, even with ultrasonic treatment, there still remained an excessive residual surface contamination attributable to chemosorption during neutron bombardment and embedment upon penetration. Selective diffusion plays a role here: Na and Au diffuse easily, Zr and La diffuse sparingly. After a wash with acid-peroxide solution, the distribution of $^{24}$Na isotope was found to be almost the same as before, indicating that most of it had spread over the volume with little left on the surface. The distribution of $^{198}$Au isotope was found to change with increasing bombardment doses, first most of it remaining on the surface and then gradually more of it diffusing into the volume upon buildup of the bombardment dose. References 3: all Russian.

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## COMPUTER-AIDED AUTOMATIC PROCESSING OF CHROMATOGRAPHIC DATA

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 53, No 1, Jan 87 (manuscript received 20 Dec 85) pp 4-7

[Article by A.B. Rabinovich, A.G. Lerman, A.A. Grinberg, Yu.Z. Aksel, V.A. Kvasova and S.A. Leontyeva, All-Union Scientific Research Institute of Petroleum Refining, Moscow]

[Abstract] An automatic data processing system has been developed specifically for fast and reliable processing of chromatographic data. It is based on a YeS computer complex operating in the "off-line" mode with data input on a magnetic tape. It includes a 100 kHz master oscillator and an analog-to-digital converter. The latter is interfaced with the data input device through a module containing a frequency stabilizer, a frequency divider array down to 1 Hz, and a decoder, all built on series 155 microcircuit chips. Software includes the KHROMVIV data bank on a magnetic disk. Input data from chromatograms are processed in three stages: first qualitatively with an intermediate readout, then quantitatively with input of supplementary data and another intermediate readout, followed by editing an final data output. The system is already used successfully for analyzing products of fractional distillation of petroleum. References 4: all Russian.

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CSO: 1842/74

UDC (546.92+546.985):543.420.62

## DETERMINATION OF Pd AND Pt IN CATALYSTS BY SPECTROPHOTOMETRIC TITRATION IN AQUEOUS-ORGANIC MEDIA

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 53, No 1, Jan 87 (manuscript received 7 Mar 86) pp 7-8

[Article by O.L. Samorukova, Moscow Institute of Chemical Technology imeni D.I. Mendeleyev]

[Abstract] A new method of determining Pd and Pt in catalysts by titration has been developed which does not require separating these metals from the matrix and yet is highly selective. Its gist is formation of extraspherical complexes by solvated $K^+$ cations and Pd,Pt-chloride anion complexes in 90% aqueous solution of dimethyl sulfoxide, in which they are much more stable than in pure water. Titration is performed in a spectrophotometer, using as "nitchromazo", which form with potassium an unstable complex. The selectivity is improved by addition of ethylenediamine-tetracetic acid, which masks impurity elements in a catalyst. Such a titration was performed in an SF-16 spectrophotometer at the $\lambda$= 626 nm wavelength, specimens of a catalyst weighing 1 g each having been etched with 6 ml of HCl + $HNO_3$ concentrate. A statistical analysis of the readings included tests for systematic errors, which were found to be insignificant. References 8: all Russian.

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CSO: 1842/74

UDC 546.19:543.252

DETERMINATION OF As IN FORM OF ELECTROCHEMICALLY PRODUCED $AsH_3$

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 53, No 1, Jan 87 (manuscript received 1 Nov 85) pp 18-19

[Article by L.Yu. Firsova and Yu.A. Kovalenko, Far-Eastern Department for Water Resources of Industrial Enterprises, All-Union Scientific Research Institute of Water Supply, Sewage, Hydraulic Structures, and Engineering Hydrogeology, Vladivostok]

[Abstract] The cathodic behavior of As at a Pt electrode was evaluated by the potentiodynamic method in pure 2 M $H_2SO_4$ and in 2 M $H_2SO_4$ containing dissolved As alone, also with $Cu^{II}$ or with $Fe^{III}$ which most commonly appear with As in the tailings of the nonferrous-metals industry. All electrolytes had been purged of oxygen with a stream of argon. The results indicate the feasibility of quantitative determination of As by way of electrolysis which will yield $AsH_3$ without its adsorption by the electrode and without interfering reduction of $Cu^{2+}$ or $Fe^{3+}$ ions. Experimental implementation of this simple method with "white ribbon" filter-indicator paper yielded reproducible, and thus reliable, results. Most sensitive was found to be such paper treated with 5% alcohol solution of HgBr for 40 min and then dried for 40 min at a temperature of 105°C. References 6: 4 Russian, 2 Western.

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CSO: 1842/74

UDC 538.22

METHODS OF DETERMINING PARAMETERS OF APPARATUS FOR MEASURING MAGNETIC PROPERTIES OF SHEET SPECIMENS OF ELECTRICAL STEEL

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 53, No 1, Jan 87 (manuscript received 27 Feb 86) pp 35-37

[Article by T.I. Maslova, I.A. Zhuravlev and L.Kh. Radionova, Ural Center for Standardization and Metrology, Sverdlovsk]

[Abstract] There are essentially three sets of procedures for measuring the magnetic properties of electrical steel in sheet form, namely measuring the actual properties of material as delivered, estimating the properties relative to established norms for grade identification, and measuring on the basis of residual stresses after heat treatment. The basic properties of concern are magnetization curve and core loss, measurement of which requires determining the effective mass or length of path in an equivalent uniformly magnetized specimen, the main core loss in the yoke of the apparatus, and the extra core loss associated with transverse magnetization of sheet steel samples. The latter two corrections are determined on the basis of standard specimens. Measurements are made in Epstein apparatus with a magnetizer having usually a single wound yoke, two wound yokes without a gap, two stacked yokes with a

gap, or a frame yoke, each designed for specific sizes of sheet steel samples. Calibration and standardization of the equipment includes determination of its accuracy, namely random and nonremovable systematic as well as total errors of loss measurement at a fixed amplitude of magnetic induction and of induction measurement at a fixed amplitude of magnetizing field intensity. References 1: Russian.

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CSO: 1842/74

UDC 666.3/.7:620.17

STUDY OF FRACTURE KINETICS IN CERAMIC MATERIALS ON BASIS OF FLAT SPECIMENS TESTED IN DUAL TORSION

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 53, No 1, Jan 87 (manuscript received 20 Jun 85) pp 72-74

[Article by S.M. Barinov, D.A. Ivanov, Yu.L. Krasulin (deceased) and G.A. Fomina, Institute of Metallurgy imeni A.A. Baykov, USSR Academy of Sciences, Moscow; Moscow Institute of Aviation Technology imeni K.E. Tsiolkovskiy]

[Abstract] Crack propagation and stress concentration in brittle materials such as ceramics are best tested by the method of dual torsion using notched flat specimens, which ensures stable crack propagation at a constant velocity v, on the premise that the stress intensity coefficient $K_s$ does not depend on the crack length L and that the compliance increases at a rate proportional to the crack length. Specimens are supported at the edge with a notch, on both sides of the latter, and loaded in pure flexure. For a determination of the $K_s$-v diagram there are three procedures: 1) periodic intermittent loading with intervening relaxation at constant strain rate in the case of high crack propagation velocity, 2) continuous loading at constant strain rate in the case of medium crack propagation velocity, with a plateau on the stress-strain diagram, 3) loading at constant strain rate with immediate crack length measurements during the process in the case of slow crack propagation. The readings are in each case evaluated in accordance with applicable relations of deformation and fracture mechanics. This methodology is well suited for study of the fracture kinetics. While the $K_s$-v diagram is directly applicable to slow fracture of structurally homogeneous ceramics only, it may be ambivalent for materials with laminate-granular structure owing to possible alternate acceleration and retardation of cracking. References 8: 3 Russian, 5 Western (1 in Russian translation).

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UDC 621.791.052.08:620.179.16

ULTRASOUND QUALITY CONTROL OF BIMETALS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 1, Jan 87 p 24

[Article by P.I. Gergel and V.N. Yevsyukov, engineering, Ukrainian Scientific Research and Design Institute for Chemical Machine Building (Severodonetsk Branch)]

[Abstract] The relationship between the quality of a joint and the average amplitudes of the base and echo signals emitted from the interface of bimetal joints was studied. The following bimetals were tested: 09G2S+M1R, 09G2S+EP53, 12KhM+12Kh18N10T, 20K+EI943, AD0+VT1-0, and M1R+VT1-0. Thickness was 20 to 30 mm for the base metal and five mm for the surfacing metal. The ultrasound was introduced from the side of the surfacing metal. Standard converters were used to measure the amplitudes at working frequencies ranging from 2.5 to 5.0 MHz. The converters were aligned independently for the echo signals and in tandem for the base signals (7° angle of inclination for the acoustical axis). Several readings were taken from various sections of each joint and averaged. Ratios of average amplitudes of signals from defective joints to average signal amplitudes from non-defective joints were calculated and entered into a table. To calibrate the sensitivity of flaw-detecting instruments, these ratios are added to or subtracted from the readings of these instruments. The results of ultrasound quality control were consistent with metallographic analysis and quality control using standard specimens to calibrate instrument sensitivity. References 5: all Russian.

13050/9716
CSO: 1842/69

UDC 620.178.2:669.14.018.29

TENDENCY OF TYPE 10KhSND STEEL TO THERMAL EMBRITTLEMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2, Feb 87 pp 15-17

[Article by V.M. Goritskiy and G.R. Sheyderov, Central Scientific Research and Design Institute for Construction Metalwork]

[Abstract] A comparative estimate is presented of the tendency of low-alloy steel with ferrite-pearlite and martensite structures to thermal embrittlement. Studies were performed on a 10 mm sheet of 10KhSND steel (0.10% C, 0.90% Si, 0.57% Mn, 0.58% Ni, 0.77% Cr, 0.30% Cu, 0.020% S, 0.030% P). Plates measuring 70 x 120 x 10 mm were austenitized at 920, 1050 and 1175°C for 1.5 hours, then hardened in water and tempered at 680°C. Some of the plates were also cooled from austenitization temperature in the furnace to achieve a ferrite-pearlite structure. Thermal embrittlement was evaluated after holding in the furnace at 300-550°C for 20-5000 hours. Impact testing was performed on specimens cut from the plates in the direction transverse to the

rolling direction. The steel with ferrite-pearlite structure shows a tendency to thermal embrittlement under these conditions, the maximum occurring at 400°C. Thermal embrittlement of the steel with ferrite-pearlite structure was approximately half as great as that of steel with tempered sorbite structure. Development of thermal embrittlement is accompanied by an increase in the fraction of intergrain fracture in brittle fracture zones. Austenitization temperature does not influence the relationship between brittleness temperature and share of intergrain fracture in specimens. References 5: all Russian.

6508/9716
CSO: 1842/90

UDC 546.831'261'171'1

# COATINGS OF Zr NITRIDE AND Zr CARBONITRIDE PRODUCED BY METHOD OF GASEOUS-PHASE METALLURGY

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 1, Jan 87 (manuscript received 21 Mar 85) pp 63-67

[Article by V.V. Kosukhin, V.F. Funke, V.I. Minashkin, V.S. Smirnov and Yu.P. Yefremov]

[Abstract] Coatings of Zr carbonitrides covering the entire $Zr(C_{0.007}N_{0.99})$-$Zr(C_{0.86}N_{0.14})$ range deposited on substrates of graphite or low-carbon steel at temperatures of 900-1200°C from a gaseous phase containing $ZrCl_4$, $CH_4$, $H_2$, $N_2$ and Ar were examined for elemental and phase composition. The coatings had been built up at rates of 0.5-1 μm/min. Their adhesion was sufficiently strong to inhibit peel-off during grinding or cutting. Chemical analysis was performed in an AGAVA-2P spark mass-spectrograph yielding the concentration of nonmetallic elements with an error not larger than 20%. Phase analysis was performed at room temperature in a URS-50 IM x-ray spectrograph with a scintillation counter using a $CuK_\alpha$-radiation source and a Ni-filter. The lattice parameter was calculated accurately within ±0.005 Å from the centers of gravity of diffraction peaks, over the entire range of ZrC concentration in the ZrN-ZrC system. Its temperature dependence was measured over the 20-1700°C range in a high-temperature vacuum x-ray chamber, a modified version of a diffractometer attachment, with a Zr nitride coating $Zr(N_{0.99}C_{0.007}O_{0.003}Cl_{0.004})_{0.93}$ deposited on a Mo substrate which had been annealed at a temperature of 1200°C under a vacuum of $6.65 \cdot 10^{-3}$ Pa for 30 minutes. The results have revealed in the coatings almost pure ZrN accompanied by a carbonitride second phase which remains stable in a nitrogen atmosphere at temperatures up to 2000°C. A comparison with data on $ZrN_{0.93}$ coatings produced by the method of powder metallurgy reveals a different temperature dependence of the thermal expansion coefficient, linear in both cases with the same thermal expansion coefficient at high temperatures but coatings produced by the method of gaseous-phase metallurgy having a much smaller thermal expansion coefficient at low temperatures. References 9: 2 Russian, 7 Western (3 in Russian).

2415/9716
CSO: 1842/73

UDC 620.179.13

# THERMAL INSPECTION OF PRODUCTS MADE OF CARBOPLASTIC-ALUMINUM COMPOSITE MATERIAL

Sverdlovsk DEFEKTOSKOPIYA in Russian No 12, Dec 86 (manuscript received 3 Apr 86) pp 56-59

[Article by V.P. Vavilov and V.K. Okonechnikov, Scientific Research Institute of Electronic Introscopy, Tomsk]

[Abstract] Specimens of a carboplastic-aluminum composite material were inspected by the thermographic method in an experiment set up to yield sufficient statistical data for evaluation of the sensitivity of this method. The specimens consisted of two layers, a 2.5 mm thick carboplastic plate and a 1 mm thick aluminum plate, each 210x50 $mm^2$ large. They were held together by a 0.2 mm thick film of a polymer adhesive but incompletely, with up to 30 intentional voids 10x10 $mm^2$, 15x15 $mm^2$, 20x20 $mm^2$ large left to stimulate flaws. The temperature field was recorded in the bilateral mode with a TV-03 thermal imager, using a TsPTP-1M digital thermogram converter with memory and also an ID-2 teledefectoscope. The specimens were heated either by a stationary lamp covering a 200x200 $mm^2$ area with a power density of 5 $kW/m^2$ uniformly within 5% or by a slowly moving heat beam covering a 10x10 $mm^2$ area with a power density of 10 $kW/m^2$. The data have been analyzed statistically, with sensitivity defined as the characteristic dimension of a flaw detectable above the false-alarm level and with the Neyman-Pearson criterion applied to results of inspection by the moving heat beam. The false-alarm level had been established previously by inspection of flawless specimens. The results indicate that bilateral thermal inspection with a moving heat beam is less efficient and has a lower probability of flaw detection according to the Tanimoto criterion, though it is much easier to set up for optimum inspection time characteristics. Statistical evaluation of the inspection sensitivity must take into account noise produced by surface roughness of the carboplastic material, anisotropy of its thermophysical properties, and fluctuations of its emissivity or absorbtivity. The authors thank V.A. Baranov for assisting in interpretation of the data. References 6: all Russian.

2415/9716
CSO: 1842/72

## METAL WORKING BY ELECTRICAL STIMULATION DESCRIBED

Moscow ZNANIYE-SILA in Russian No 11, Nov 86 pp 15-16

[Interview with I.I. Novikov, corresponding member of the USSR Academy of Sciences, conducted by Ye. Goltsman, ZNANIYE-SILA correspondent, date and place not given: "Paths of Electrotechnology", under the rubric: "Practical Implementation of the Decisions of the 27th CPSU Congress"; first two paragraphs in boldface in source, third paragraph in italics in source]

[Text] To improve the structure and quality of construction materials based on the creation of a new progressive technology and the implementation of resource conservation in economic development.

"Basic directions in the economic and social development of the USSR for 1986 to 1990 and the period up to the year 2000"

Approximately one-third of all fuel extracted from the Earth's interior is used in metallurgy and metal-working. The amount of energy used in processing metals can be significantly decreased, however. In particular the research being conducted in the laboratory of I.I. Novikov, corresponding member of the USSR Academy of Sciences, at the Soviet Academy of Science's Metallurgy Institute imeni A.A. Baykov is paving the way towards this. I.I. Novikov talked about new electrotechnology in a conversation with our correspondent.

Correspondent: Manufacturing the instruments, devices and components necessary for space exploration, progress in electronic engineering and creating the next generation of computers requires the use of new metals endowed with specific properties. Sometimes heat-resistant materials are needed, while other cases require materials which can withstand very low temperatures. The designers of the new technology want materials which are strong, reliable, durable and--sometimes--have high electrical conductivity or thermal conductivity. Briefly put, the requirements are many. At times, these requirements contradict each other and cannot always be fully satisfied. By increasing the strength of an alloy, we obviously make it more difficult to work. Can new processing methods that would help in obtaining such materials be found?

I. Novikov: A hard look is currently being given to methods for working metals. These methods have been handed down through the generations from time immemorial, and have changed only slightly throughout the centuries. Even

now, the semi-finished product must be heated to a high temperature in order to give it the required shape.

Corresepondent: But an alternative way of working has not been found yet, has it?

I. Novikov. The metal obviously has to be heated. This is necessary for forging, rolling, drawing and stamping. However, a lot of energy is wasted during these procedures.

Judge for yourself. The objective of heating is to increase plasticity. Even though only a small portion of the semi-finished product is usually worked, however, the entire semi-finished product is heated -- in many instances not just once, but up to a hundred times. This means that most of the power expended is literally thrown to the winds. Ecological problems having to do with the thermal "pollution" of the environment arise as well.

But that's not all. Along with power, a huge amount of expensive and scarce metals are lost as well. The higher the temperature of the metal being worked and the longer it is exposed to the air, the more scales form. More sophisticated methods have to be developed to protect metals against oxygen, nitrogen and hydrogen. But waste still cannot be avoided totally. During the forging of molybdenum, 12 to 15 percent of the metal is lost to oxidation, while 10 to 30 percent is wasted during the working of niobium or tantalum.

In addition, the physicochemical properties of a metal deteriorate when it is repeatedly heated. Many alloys have highly volatile constituents which are quite frequently liberated during heating. With them go all the virtues of the alloy as well.

Modern precision instruments have quite a few elastic components and different springs manufactured from high-strength thin strips. These strips are currently made by flattening wires consisting of super high-strength metals and alloys--a tungsten-rhenium alloy, for example. It was believed up until now that the wire could not be rolled or flattened into a microscopic narrow strip unless first heated to a high temperature. The problem is, though, that the quality of the semi-finished product deteriorates during this: becomes weaker.

The difficulty in working tungsten and its alloys is confronting scientists with several very complex tasks. The most high-melting and heat resistant of all known metals, tungsten is used in various electronic devices and equipment. It could be used on a much wider scale if it were not so brittle. At present, tungsten can only be worked after it is heated to a temperature of 1000 to 1500°C in an inert atmosphere or vacuum. It goes without saying that this leads to a deterioration in the quality of the products.

New ways of developing technologies may frequently be found by interpreting old, customary methods. It turns out that heating makes it possible to shape parts and expend much less power in the process.

Correspondent: What exactly do you mean?

I. Novikov: All problems that arise are interconnected and have the same roots. Old methods can be reviewed and new ones created on their basis. A more improved technology is obviously needed. Along with co-workers at our laboratory, K. Klimov has developed a fundamentally new rolling method. It essentially works as follows. The semi-finished product is heated with a high-density electric current. The current is passed from one roll of the rolling mill to the next transverse to the semi-finished product, so that only the portion of the semi-finished product being worked is heated. This in turn reduces power loss to a minimum. We do not heat treat the product dozens of times, but only once or several times, which also cuts power losses. It was found that the product does not have to be heated to a high temperature with the new processing method--the metal becomes plastic already at temperatures ranging from 200 to 300°C. Because noticeable scales were not observed to form at these temperatures, significant losses of metal are prevented.

The new processing method is also set apart by the nonuniform distribution of electric power across the semi-finished product. The concentration of power (to be more precise, the density of the electric current) is greatest at the microscopic projections of the surface. The metal here becomes pliable and smooth, its surface evening out and friction forces decreasing. The electric current acts as a kind of lubricant whose efficiency can be easily regulated. The decrease in friction forces quite obviously leads to a savings in power as well.

Correspondent: The traditional methods of metal-working frequently worsen their properties. What about new electrotechnology?

I. Novikov: A highly interesting pattern may here be observed. Plastic deformation has to do with irreversible changes in the shape of the semi-finished product. Mechanical forces inevitably create numerous different kinds of defects in the metal, including microscopic cracks and various types of distortions in crystalline structure. Microscopic cracks hinder the smooth flow of electric current. The current "flows around them", but its density changes during this, increasing significantly at the tips of the microscopic cracks. Because of this, the temperature increases, the destruction processes which always accompany any plastic deformation weaken, and the worked metal turns out to be stronger than the initial semi-finished product. Photographs taken with an electron microscope indicate a noticeable improvement in the structure of the metal.

As I stated above, the microscopic projections on the surface of a metal worked using new electrotechnology become smoothed out. The cracks also become "filled up", not only inside of the semi-finished product, but on its surface as well. This is very important, given the fact that an even and crack-free surface can significantly increase the strength of any product.

Changes in the structure of a metal triggered by simultaneous action of mechanical forces and heating, as well as of electric and magnetic fields, have a beneficial impact on the product that is obtained. They are the reason behind a remarkable phenomenon--residual plasticity. Flattened items

made of tungsten exhibit a much higher level of plasticity than the initial wire. Tensile tests showed that the residual elongation of the flattened item is five to ten times higher than in the semi-finished product.

Correspondent: Electric current was also used earlier in plastic metal working. What is new about your approach?

I. Novikov: Earlier, electric current was fed lengthwise along a semi-finished product which had been heated as a whole. The current across the semi-finished product could not exhibit too high of a current density, as the metal would have been heated to too high of a temperature as a result.

We chose an altogether different way. We apply very high-density currents, but run them transverse to the semi-finished product within deformation zone only. The metal is only heated to a temperature of 200 to 300 degrees and loses nothing in terms of strength.

Correspondent: What metals are being worked with the help of electro-technology?

I. Novikov: Virtually all of them. From alloys of light metals--aluminum, magnesium, lithium, beryllium--all the way to the most high-melting anad low-ductility alloys of molybdenum, tungsten and rhenium.

Ferro-cobalt alloys are widely used in the electrical engineering industry. High-quality strips are manufactured from them, but repeated rolling as well as complex and expensive hardening and interstitial annealing are also applied here. Using an electric current for rolling makes it possible to avoid annealing and hardening.

Electrical stimulation may be used successfully in working metals regardless of their state--crystalline or even amorphous. The fact that amorphous materials can be worked through electrical stimulation is very curious from the standpoint of explaining the phenomenon theoretically. The point is that while the interaction between electrons and a rearranged crystalline structure can sometimes explain why the plasticity of a metal increases while exposed to high-density electric current, an amorphous metal has no crystalline structure and therefore cannot be rearranged. Moreover, theoretical analysis and numerous experiments has shown that the interaction between electrons and shifts in the crystalline structure is so slight even in a crystalline metal that it plays no role whatsoever in the metal acquiring plasticity.

Profound changes in structure is what improves the physicochemical properties of metals and alloys. The diffusion processes at work near microscopic cracks and other structural defects intensify during the nonuniform heating of a semi-finished product. There is simply no such thing as "electronic plasticity" without heat.

Correspondent: Where do things stand with respect to introducing the new electrotechnology into practice?

I. Novikov: The principles behind the new processing method were experimentally tested by scientists at our institute. We flattened a thin wire made of either tungsten, molybdenum, rhenium or various alloys--molybdenum-rhenium, tungsten-rhenium and many others--into a narrow strip. The flattened tungsten wire made with the new processing method is right up there with the best the world has to offer as far as technical parameters are concerned. A method for obtaining tungsten coils having a very small twist radius without high-temperature heating was found for the first time.

After numerous experiments fully corroborating the validity of our approach were carried out, staff members at the Metallurgy Institute imeni A.A. Baykov of the Soviet Academy of Sciences, joined with sectorial enterprises of the industry, developed an industrial processing method of manufacturing precision strips made of tungsten for a large number of electronic devices. Optimum operating conditions were determined, special equipment designed and the necessary technical specifications drawn up. The flattened tungsten wire obtained with electrical stimulation rolling method is being employed in the serial production of many kinds of ultra-high-frequency engineering devices. Results are in evidence already. Replacing the molybdenum strip with a tungsten strip in one of the devices alone generates a savings of over 1.9 million rubles annually.

But to say that everything is perfect at this point would be untrue. Waste and rejects are virtually absent during the working of brittle and low-plastic metals (according to the new electrotechnology). One would think that staff members of the Ministry of Nonferrous Metallurgy would be the first to show an interest in the potential vast resources this might bring to the industry. Unfortunately, we still come across nothing but indifference on the part of the staff members at this Ministry, as we did previously with the staff members of the Ministry of Ferrous Metallurgy.

Correspondent: What about the prospects for the industrial application of these new methods?

I. Novikov: They will enable--and we can see this now already--the elimination of expensive and labor-intensive operations in which the semi-finished product is separately annealed and heated at virtually all stages. In many cases, it will be possible to abandon the use of reheating furnaces. In addition, the number of rolling stands will drop, the design of rolling equipment will be simplified and its metal content decreased. The basis for creating industrial processing methods for the plastic working of the least "pliable" alloys of aluminum, beryllium and chromium already exists. Working via electrical stimulation will decrease power consumption by a factor of ten--maybe more. The reduction in labor costs will be even more significant. According to calculations, partially eliminating the annealing and heating of a semi-finished product during the manufacture of, for example, steel sheet and strip will in itself result in a savings of several billion rubles annually.

I am convinced that every process involving the melting and working of metal will in the near future be based on different aspects of electrotechnology. Electrical stimulation may obviously be used successfully not only while

rolling, but in any kind of plastic metal working. The application of an electric current will also effect a significant decrease in power and material consumption. Designers will have alloys at their disposal which they can only dream about today. This means that new and improved devices and equipment will appear in many sectors of the economy.

Electrotechnology will help make manufacturing completely clean from the standpoint of ecology. It will be possible to fully automate every technological process and shift to worker-free manufacturing. It seems to me that all this would be enough to focus more attention on the working of metals via electrical stimulation.



13126/9716
CSO: 1842/64

## UKRAINIAN EXPERIMENT ON ELIMINATING METAL NONCONVERTIBLES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 6 Jan 87 p 2

[Article prepared by T. Savelev, V. Cherkasov under the rubric "Action -- What Kinds for Surpluses and Nonconvertibles" from an interview with N. Gulko, deputy head of the UkSSR Ministry for Ferrous Metallurgy Material-Technical Supply Department: "Wastes Bring Profits"; first paragraph is SOTSIALISTICHESKAYA INDUSTRIYA introduction; text in slantlines printed bold in original]

[Text] /On December 2 last year SOTSIALISTICHESKAYA INDUSTRIYA began a new action. Continuing, we will relate the experience of work on the use of nonconvertibles in the UkSSR Ministry of Ferrous Metallurgy. The floor goes to N. Gulko, deputy head of the UkSSR Ministry for Ferrous Metallurgy Material-Technical Supply Administration./

In August 1986 our ministry held an exhibition of metallurgical production waste products which could be of interest to a broad range of purchasers.

You've moved into a new apartment and want to make do-it-yourself bookshelves or moldings. You got an area in a garden-orchard cooperative and needed some pieces of pipe... Your child enjoys odd jobs, and you yourself are a handyman, but you need metal. Different kinds, but, most important, inexpensive--all those angles, bolts, sheets of roofing and other iron... Where do you find them? Mulling over this problem, we decided to prepare the exhibit about which I have spoken.

More than 70 enterprises of the republic's Ministry of Ferrous Metallurgy participated in the exhibit. It presented thousands of types of wastes and parts made from them.

Those who saw these goods had a natural question: When will they appear on the storeshelf?

At the end of September a trade center rose on the outskirts of Dnepropetrovsk. Here a buyer can acquire the metal he needs for his home at a discount. This is good for the user, but what about the government? To benefit the government, the trade center must do more than just sell various small household gadget items, but make use of surplus unused physical assets. This is the only way to make a profit. But where to get the goods?

Preparing to work in the new manner, to introduce complete self-accounting in the branch, Ukrainian metallurgists performed a strict accounting of nonconvertibles. Commissions looked into all the nooks and crannies, took careful inventory and certified work areas and equipment, and counted up all the surplus material resources. It was discovered that, as of 1 January 1986, UkSSR Ministry of Ferrous Metallurgy warehouses had accumulated unneeded stock worth 45 million rubles.

What couldn't be found there?! Scarce metal wastes. Costly ferrous metal scrap. Machines ordered no one knew when and why. Rubber engineering goods. And even hundreds of thousands of rubles worth of coveralls, which, as they say, would be covered with dust in a few years. The ministry thus unexpectedly had become the owner of countless valuables which it didn't need. What to do with them?

The suppliers of the republic's Ministry of Ferrous Metallurgy contacted Gossnab agencies with territorial administrations in Donetsk, Dnepropetrovsk, and Zaporozhye. Meetings were held where they publicized their stores and took orders for selling the nonconvertibles. Not everything, unfortunately, since Gossnab also needed time to find buyers. It too became flustered when it saw such wealth.

Then the Ukraine Ministry of Ferrous Metallurgy began to look for buyers on its own. In Donetsk, Ukraine Gossnab held a regional industrial trade fair in which we actively participated. They invited representatives from all union republics. Metallurgical enterprises offered their goods and people bought what they needed. Nonconvertibles amounting to 18.9 million rubles have now been sold, including equipment for 7.6 million.

This fair was, of course, not only troublesome, but costly. Sending people, transporting the goods -- all this wasn't cheap. You could take a chance on such a fair only once for promotional purposes, as they say, to show the goods to best advantage. It was no accident that there were more sellers than buyers. It became clear that other more reliable and stable methods of getting rid of nonliquids were needed.

This also required a specialized trade center in Dnepropetrovsk. Now, along with sales of metal wastes to the population, its task includes selling nonconvertibles. For this, enterprises generally do not have to bring their unneeded goods: here at the trading center only bargaining, buying, and selling are done. The goods themselves still remain with the owner.

But the buyer doesn't know what's where. There aren't enough newspapers to announce the sale. We organized a section to study demand. In addition, having copious information we turned it over to Gossnab agencies which are always full of visitors. Only through interaction with these agencies will our work be fruitful. We must know precisely what goods are available; they must determine demand and centralize it. Then, instead of constantly turning down their clients, they can write the desired order, let's say, for a machine tool or wire, to us, and we'll get it from us metallurgists.

Moreover, the trade center has goods which the populace doesn't need: bearings, tools, spare parts, pipe, which no home needs, even in a small

quantity. No one goes anywhere for five fist-size bearings. All these goods must be centralized at Gossnab bases, and that agency will redistribute them in the planned order.

The republic's Ministry of Ferrous Metallurgy turned to Ukraine Gossnab and Goskomtsen [State Committee on Prices] in all disputes and in 3 days (a case unheard of under the previous red tape) received an exhaustive response from both committees. Unused physical assets are sold at prices agreed on by both sides, but not exceeding current wholesale prices.

I repeat, it took only 3 days to solve the price problem--an illustrative example.

Since the UkSSR Ministry of Ferrous Metallurgy has begun selling nonconvertibles, their quantity has not diminished, but increased. As of 1 January 1986 their value was 45 million rubles, but now it is approaching 46 million. And goods worth almost 19 million have already been sold. How can we explain this paradox?

The facts are gratifying. Enterprises simply began digging into their bins to get rid of unneeded equipment. And that's how it should be: whatever doesn't bring profit should be used advantageously somewhere else.

USSR FERROUS METALLURGY MINISTRY REACTS

[Interview with G. Nekrasov, head of the USSR Ministry of Ferrous Metallurgy Material-Technical Supply Administration: "Commentary from USSR Ministry of Ferrous Metallurgy"; text in slantlines printed bold in original]

[Text] /How does the USSR Ministry of Ferrous Metallurgy rate the Ukrainian suppliers' experiment. G. Nekrasov, head of the Ministry's Material-Technical Supply Administration answers this question./

"In my opinion, this center is a lucky find. It makes it possible to facilitate and organize the process for selling assets the branch doesn't need."

/Are there plans to create such trade centers in the country's other industrial centers?/

"Yes, and soon. The other day USSR Minister of Ferrous Metallurgy S. Kolpakov instructed heads of commercial-financial services in all-union industrial associations to go to Dnepropetrovsk and study the trade center's operation in depth. The experiment will be spread to branch enterprises.

The value of the Dnepropetrovsk experiment is not only that it accelerates the return of surplus and unused resources to the national economy. Sale to the populace of industrial wastes, nonconvertible stocks, and physical assets formerly in use makes a significant contribution to achievement of the "Integrated Program for Development of Consumer Goods and the Service Sectors for 1986-2000."

Thus, everyone wins -- the buyer, the seller, and the government. And this means that creation of such trade centers is completely justified and substantiated. Now it is a matter of extensive and rapid organization.

12809
CSO: 1842/88

RUSH TO BREAK PRODUCTION RECORD RESULTS IN ACCIDENT

Moscow PRAVDA in Russian 11 Jan 87 p 2

[Article by N. Krivomazov and V. Cherpanov, staff correspondents: "After a Record: An Accident"; text in slantlines printed bold in original]

[Text] Chelyabinsk Oblast--/New Year's Eve at the Magnitogorsk Metallurgical Works was filled with anxiety and the self-sacrificing effort of hundreds of people hurrying to the assistance of furnace No. 9./

One of the four air heaters fell off the furnace during startup. The multiton metal and brick hulk came down on the track and buried two railroad men.

It's not enough that the blast furnace was left without a life support system -- the railroad tracks were also torn up. And they provided 24-hr-a-day service to the other furnaces, each of which was filled with hot metal. These furnaces had to be kept operating and an even greater disaster prevented.

One of the routes was free of debris by 1 am. Gas-cutters R. Nuriyev, A. Uglitskiy, V. Kuzmenko, and V. Shestakov were 40 meters up. They cut the remains of the reinforced shell. People carried away the debris and deslagged the waiting furnaces. By noon the operation of the first eight furnaces was completely normalized. And only the ninth asked, "How could this have happened?"

A state commission headed by USSR Deputy Minister of Ferrous Metallurgy V. Ashpin found "brittle failure on the air heater plating."

After repair, the air heater was set to heat gradually, with ordinary wood. It seemed like a long time, 20 days, and they decided to push the process by increasing the gas feed rate and sharply raising temperature. This had been done for not one year, not two, but since 1973.

There were other exceptions to the rules set by the local norm. A hole was cut in the plating of unit No. 30. When the work was completed, these holes were supposed to be closed up with new plate. They did it more simply: they put back the old ones.

When an air heater is being heated, the area must be cordoned off to keep people at a distance. If rail transport is provided, these operations must be coordinated with the startup schedule. The local schedule again turned out to be incomplete: it did not take into account this combination of circumstances.

As we see, the discussion is not so much about the ChP [extraordinary situation] at Magnitka as about mandatory adherence to instructions, precise following of the law, observation of the required formalities, in which careless "creativity" and poorly planned, independent action become unthinkable and impossible.

They occasionally say that heroism is sometimes seen in trenches dug out of slovenliness and irresponsibility. To these characteristics can be added the desire to surprise with an impressive number, a good report. Thus, at furnace No. 9, by pushing the unit's startup, they simply forgot common sense. We cannot sacrifice anything more valuable for the plan, or even for a record.

On the last day of last year, Magnitka metallurgists reported their record -- they had smelted 16 million tons of steel! Magnitka alone produces more metal than other countries. We did not dare turn this announcement over to the editors, since the gross figure is not the whole story. A record, yes, gloriously earned, but there are still many complaints about the metal's quality. Perhaps, as they say, better less, but better? Nevertheless, someone thought that this "gross" was too little.

"Soyuzmetallurgprom" called the senior steel melter at Magnitka. Chief engineer S. Afonin said, "We need another 17,000 tons of steel so that the Ministry figures for the year match to a tee."

"That's too much," was the answer. Because they already had the branch record.

There was no time to undertake more than this unexpected "addition" -- the explosion resounded.

12809
CSO: 1842/88

ACTIONS TO MAKE UP SHORTFALLS IN FERROUS METALS

Moscow EKONOMICHESKAYA GAZETA in Russian No 9, Feb 87 p 3

[Article: "To Make Up a Debt: Ferrous Metallurgy"; first paragraph is boxed EKONOMICHESKAYA GAZETA introduction; text in slantlines printed bold in original]

[Text] /The last issue of EKONOMICHESKAYA GAZETA published an announcement by the USSR Central Statistical Administration on the results of industry work for January 1987. Shortfalls were permitted in machine building, ferrous metallurgy, and several other industries. As operating data unfortunately show, few collectives are working without shutdowns and interruptions in February. Senior officials in ministries and departments tell EKONOMICHESKAYA GAZETA and TASS correspondents about measures intended to make up this shortfall and ensure unconditional fulfillment of plans and contractual obligations./

[Article by USSR Deputy Minister of Ferrous Metallurgy B. I. Ashpin]

The debt at the "Soyuzmetallurgprom" All-Union Industrial Association in January was 70,000 tons of steel and 135,000 tons of rolled stock. Of course, we can cite several objective difficulties, but the main reason for this shortfall was that the plant was unprepared for work in winter: everyone remembers the January freezes and snow drifts. Breakdowns in equipment and assembly inspection, and their untimely repair took their toll. This might explain the unplanned downtime for blast furnaces and converters at the Cherepovets and West Siberian Metallurgical Works.

The main task today is not only to analyze the causes, but also to work to make up the debts and to rapidly exceed planned indicators. Association managers visited the debtor enterprises, listened to specialists' and workers' opinions, and efficiently solved production problems on site. Forces were assigned to repair equipment, and a steady supply of scrap and refractories to prepare ladles was ensured.

/Enterprise Party committees have done a great deal of work. Collectives are decisively geared to eliminate the shortfall./ Thus, the Cherepovets Combine made demanding commitments to increase the production rate. Work has already stabilized. Since the beginning of February 10,000 tons of

steel above target have been produced there. Every day 2,000 tons of finished rolled stock above the production rate are manufactured. In March the collective has to exceed planned targets.

A large debt was incurred at the Amurstal Plant--20,000 tons of steel. A year ago they put into operation a second electric steel melting shop, but there are problems bringing it to design capacity. This, of course, is holding the combine back.

The undersupply of scrap also affected the plant's work. This problem has been solved, and production provided with raw stock. In a short time several major organizational measures have been carried out.

In conclusion, I would like to cite the Orsk-Khalilovo and West Siberian and the Moldavian and Belorussian plants. Collectives there permitted a slight shortfall in the beginning of the year, but they didn't panic or throw in the towel. They found reserves, and in February and early March they completely paid up their debts.

[Article by UkSSR Deputy Minister of Ferrous Metallurgy B.D. Gladush]

[Text] A worrisome situation developed at Ukraine metallurgical plants at the beginning of the year. In January they owed the country 91,000 tons of iron, 130,000 tons of steel, and 181,000 tons of ferrous rolled stock. Only two metallurgical combines, Krivorozhstal and Makeyevkg met the month's target.

First, the reasons for this "slide." The list of debtors is "headed" by the Yenakiyevo Metallurgical Plant and the Dneprovskiy Combine imeni F. E. Dzerzhinskiy. In January these enterprises were 100,000 tons of iron short, more than the entire branch. And the culprit is not the severe winter which some managers used as an excuse, but that the equipment was unprepared for strenuous, steady operation and that there were violations of technological discipline.

For example, at the Combine imeni F. E. Dzerzhinskiy two of the trans-loader's ore buckets broke down at once in the summer. Even by immediately switching the ore yard to excavators they could not maintain even half the capacity of this production section, which is still in a fever. And the new reloaders will go into operation only by next winter. Luck? But in January, two blast furnaces remain shut down because of an accident. In 9 days they fell 25,000 tons of metal short. Breakdowns in the blast furnace shop were immediately reflected in steel melters' work. As a result, in January the plant in Yenakiyevo and the combine in Dneprodzerzhinsk owed 30,000 and 32,000 tons of steel respectively. But the "leaders" in under-supplying rolled stock are the Kommunarsk and Zhdanov imeni Ilich Works. They owe 56,000 and 25,000 tons respectively. Of course, a great deal can be blamed on the disruption of ferrous metal scrap delivery. In January, the branch was short 142,000 tons of this raw material; the Kommunarsk Plant, 25,000 tons.

/Results for January forced branch headquarters to immediately introduce corrections in varius production sections./ To make up the losses, we calculated the daily output of iron, steel, and rolled stock, and we are strictly monitoring execution of the measures outlined. We reached a balance in the ceilings allocated and the actual demand for energy resources. This made it possible to reduce coke consumption per ton of output. Having increased the agglomerate's iron content, we are planning, for example, to obtain an additional 10,000 tons of iron at Krivorozhstal. The blunders in the first month forced us to consider each kilogram of raw material, each kilowatt of electricity, each working minute. Taking this into account, a strict work schedule for the industry with detailed daily breakdowns was developed. It required that time between planned assembly repairs be shortened, at least an additional 200,000 tons of scrap be procured, and scrap preparation and packaging accelerated.

Calculations have shown that, under these conditions, 114,000 tons of iron, 132,000 tons of steel, and 186,000 tons of rolled stock above target will be produded by the end of the quarter. Two weeks in February have confirmed that these plans are realistic. Most enterprises are closely following the schedule. Only collectives whose management was "programmed" for a shortfall are sliding.

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DISORDER IN FERROUS METALLURGY SCRAP PROCUREMENT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 27 Feb 87 p 1

[Article by O. Buzuluk under the rubric "On Topics of the Day": "Open Hearth Furnaces are Waiting for Scrap"]

[Text] In January and February the plan for metal scrap procurement is barely 60 percent filled, and about 1.7 million tons of raw material have not been received by reprocessing since the beginning of the year. The Russian Federation accounts for three-fourths of the total amount. The Ukraine is almost 850,000 tons short; Kazakhstan, 115,000 tons.

The "bins" of metallurgical enterprises immediately emptied; scrap reserves diminished, it was often necessary to work right off the railcars. But when a charge for remelting is readied in a hurry, without the required set of ingredients, it is difficult to expect 100 percent order fulfillment. And you can't explain to state acceptance representatives why the metal isn't of the proper grade.

Winter was hard on scrap reserves at the Krivorozhstal, Magnitogorsk, Chelyabinsk, Cherepovets, Karaganda, Kuznetsk, and Dneprovskiy imeni Dzerzhinskiy Metallurgical Works and the Zlatoustovsk Metallurgical Plant. Steel melters at the Makeyevka, Kommunarsk, and Zhdanov imeni Ilicha Metallurgical Works complain of a shortage of standard-size scrap.

Suppliers, of course, are guilty, but the metallurgists themselves are not using available reserves.

Who kept the management of the Kommunarsk Works, for example, from reprocessing their own production wastes. The scrap breaking shop is still barely loaded, and the works director, G. Yakimenko, deals with unsorted raw material arriving at the enterprise by having it dumped onto a neighboring kolkhoz field.

"Dump it, we'll worry about it later!"

So they dump it. About 15 hectares of fertile land are already occupied. Nor are Makeyevka's director S. Klyagin and Zhdanov's H. Gurov distinguished by any special desire to augment reserves by reprocessing metal wastes. A

new scrap breaking shop at Kazakhstan Magnitka is still not built, and 15,000 tons of metal wastes were dumped in front of it long ago. How to get them and put them to use? Works Director M. Akbinev gestures in despair.

"It's hard to get to the scrap now. They've done an extremely bad job of unloading it -- it's gradually sinking into the swamp..."

What were the metallurgists looking at before, what were they counting on? This question can be asked also of B. Udovenko, director of the Nizhniy Tagil Metallurgical Combine. With a 50-day scrap reserve, they became complacent. They sat with their hands folded even when it rained. It dawned on them only after the severe Ural freezes. But they couldn't save the situation: the scrap, caught in a freeze, turned into a monolith which in time had to be broken up with dynamite.

Winter also revealed other more substantial flaws. With the switch to state acceptance of goods, requirements for the quality of raw material, including secondary, also rose sharply. But restructuring was seldom possible, even at advanced enterprises. Like any other type of raw stock and materials, metal scrap must be supplied in strict accordance with standards. But the old-timers at Vtorchermet [State Trust for Procurement and Processing of Secondary Ferrous Metals] do not recall an instance when anyone demanded that they be observed, lodged a complaint, or applied sanctions.

Users are right: under self-accounting and the switch to state acceptance of products, the price for others' sins becomes too high. The same applies also, by the way, to the Soyuzvtorchermet VPO [All-Union Production Association]. Despite the normative documents adopted in this country, which clearly list who does what (ministries and agencies procure scrap, sort it and turn it over to Vtorchermet; the latter reprocesses raw materials and delivers them to metallurgical enterprises), leaders of certain sectors are in no hurry to meet these requirements.

"Why do we need scrap?! Collect it and deliver it yourselves."

With this approach, the procurement plan is laid out in a rush, but it takes a long time to get to the enterprises under the departments. There was no monthly plan for the USSR Ministry of Installation and Special Construction Work, and the Ministry of the Electrical Equipment Industry, the Russian Ministry of Geology, Ministry of Highways, Ministry of Local Industry, and Ministry of Land Reclamation and Water Resources did not have a monthly plan until January 21. Whom can you force to meet a nonexistent plan?!

However, the explanations of branch managers make all this look almost like a harmless joke. S. Podobedov, first deputy minister of the union Ministry of Installation and Special Construction Work, says he was busy.

"I was in charge, but there was a lot of work and I wasn't able to check up on it."

The explanation from M. Zhukov, deputy minister of the electrical equipment industry, differs only in details.

"We distributed the plan to the main administrations, but two of them rebelled -- A great plan, they say, but we can't manage it. So we couldn't force them."

They aren't coping with plan targets; coal miners of Chelyabinsk and the Komi ASSR, machine builders in Moscow and Leningrad, Armenia and Orenburg, Altay and Voronezh and the RSFSR State Committee for the Agricultural Industry are letting metallurgists down. Enterprises and organizations in Stavropol and Krasnodar Krays and the Moscow, Voronezh, and other oblasts are disrupting the plan.

The situation requires decisive actions to catch up and to supply ferrous metallurgy with raw material.

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## INFLUENCE OF V, Nb AND Ta ON CRYSTALLIZATION AND CAST STRUCTURE OF CHROMIUM CAST IRONS

Moscow LITEYNOYE PROIZVODSTVO in Russian No 2, Feb 87 p 8

[Article by Candidate of Technical Sciences L. M. Romanov, Doctor of Technical Sciences L. Ya. Kozlov and Engineer V.M. Bakalyarov]

[Abstract] It is important to find effective methods to control the conditions of formation and kinetics of growth of the carbide phase in chromium cast iron. The formation of large hypereutectic carbide inclusions can be prevented by decreasing growth time or by decreasing the rate of mass transfer between the melt and the carbides. This article studies the influence of elements greatly decreasing carbide activity on the process of crystallization and structure of hypereutectic cast iron. Regularities are observed in the change in the nature of crystallization and structure of the cast irons under the influence of strong carbide-forming elements. Addition of these elements decreases the number and size of primary chromium carbide inclusions. Niobium is most effective in its influence on the structure. References 2: both Russian.

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## INFLUENCE OF ALLOYING ELEMENTS ON PHASE TRANSFORMATIONS DURING HEATING OF CAST IRON

Moscow LITEYNOYE PROIZVODSTVO in Russian No 2, Feb 87 pp 10-12

[Article by Candidate of Technical Sciences Yu. A. Litvintsev and Engineer N. V. Kosareva]

[Abstract] A study was made of the influence of alloying elements on phase transformations during heating of cast iron for hardening. The chemical composition of the iron varied within the following limits (%): 3.2-3.6 C, 0.5-2.5 Si, 0.6-2.5 Mn, 0.5-2 Al, 0-0.4 Mo and 0-4.5 Co. These compositions were recommended for cast iron diesel cylinder sleeves hardened by

induction. Phase transformations were studied using dilatometric curves. It was found that modifying the chemical composition could suppress graphitization in the eutectoid conversion temperature range. The chemical composition of cast irons should be selected so that the graphitization constant is less than 3.5. Castings should not be chilled. References 2: both Russian.

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NEW TECHNOLOGY REDUCES MERCURY POLLUTION

Yerevan KOMMUNIST in Russian 17 Dec 86 p 1

[Article by S. Vasilyan, free-lance correspondent: "According to a New Technology: We Report the Details"; text in slantlines printed bold in original]

[Text] /Production of luminescent bulbs involves use of metallic mercury, which causes hazardous contamination of the environment.

The "Luys" Association's Yerevan Electric Bulb Plant has tested a new production process which substantially reduces emission of mercury vapors into the atmosphere./

According to the current process, an average of 100 milligrams of mercury is introduced into each bulb, and more than 100 million bulbs fail or burn out in this country every year.

Bulb breakage, which is accompanied by spilled mercury, pollutes soil, water, and plants, and there is a constant hazard of mercury vapor poisoning in transporting, storing, and using luminescent bulbs.

The high output and extensive use of luminescent bulbs have consistently required that designers and developers find ways to reduce the level of environmental pollution.

To do this, the Yerevan Electric Bulb Plant investigated replacement of liquid mercury by mercury compounds determined as optimum mercury feeder design. As a result, use of amalgams or chemical compounds containing mercury, for example, titanium mercuride was proposed. At normal temperatures this compound releases virtually no mercury. The weight amount introduced into a bulb is several times less than in the standard process.

Experiments on test samples of luminescent bulbs using the new feed method are now being done under shop conditions. Mercury evaporation has declined, and bulb quality has improved. To make extensive use of the new process, the USSR Ministry of Nonferrous Metallurgy's Nikitovsk Mercury Plant has become involved in preparing and organizing serial production of mercury feeders based on titanium mercuride.

At the same time, comprehensive work is being done to tool equipment and introduce the new process, which meets increased ecological requirements, into production.

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## ACTIONS TO MAKE UP SHORTFALLS IN NONFERROUS METALS

Moscow EKONOMICHESKAYA GAZETA in Russian No 9, Feb 87 p 4

[Article by E. Antonov: "To Make Up a Debt: Nonferrous Metallurgy"]

[Text] In the first month of the year, while the USSR Ministry of Nonferrous Metallurgy as a whole overfulfilled the monthly plan to sell marketable goods, 56 enterprises were unable to fulfill the production plan, while 27 enterprises did not fulfill the plan for selling products. These include the Achisay Polymetal and Zhayrem Mining and Concentrating Combines, the Moscow Aluminum Alloy plant, the Novocherkarsk and Dneprovskiy electrode plants, the Kirov and Moscow Nonferrous Metal Processing Plants, the Leningrad Krasnyy Vyborzhets Production Association, and others.

As a result, overall, the Ministry failed to meet the January plan for production of silica, secondary aluminum, phosphate fertilizers, nonferrous metal rolled stock, and graphite electrodes. Of 51 branch enterprises which switched as of 1 January 1987 to state acceptance of output, 16 did not fully meet their delivery commitments. This reduced the level at which the plan for product delivery was met throughout the branch as a whole. For January this indicator was 98.5 percent, as opposed to 99.8 percent in 1986.

In the beginning of February 1987, the Collegium of the USSR Ministry of Nonferrous Metallurgy discussed the results of the branch's work in January and outlined specific organizational and technical measures to ensure unconditional fulfillment of plan targets for the first quarter and for 1987 as a whole. A schedule was approved for eliminating the shortfall in production of individual types of goods permitted in January, and constant monitoring of its performance was organized. A round-the-clock watch of management personnel was instituted in the ministry's central apparatus, at all enterprises, and in associations.

Analysis of daily operating data shows that certain positive progress has been noted in the work of industrial enterprises. Thus, an absolute majority of enterprises which permitted a shortfall in January have firmly begun to fulfill daily targets. In accordance with the approved schedule, the production debt at Revda, Kirov, and Moscow Nonferrous Metals Processing Plants, the Kirovgrad Copper Smelter, the Almalyk Mining and

Metallurgical Works, the Leninogorsk Polymetal Works, and the Zyryanovsk Lead Works, the Bogoslovsk and Uralsk Aluminum Plants, and the Lenvtortsvetmet and Kharkovvtortsvetmet Associations is being paid off.

The Krasnouralsk Copper Smelting Combine's production was 1,288 tons of phosphate fertilizers short in January. As of 15 February, the debt had been reduced 60 percent. The Tyrnyauz Tungsten-Molybdenum Combine paid off 81 of the 99-ton January shortfall in tungsten concentrate, which is 80 percent of the debt.

At the same time, there has been no improvement in work at the Achisay Polymetal and Karagaylinskiy Mining and Concentrating Combines, the Mikhaylovsk Nonferrous Metal Processing Plant, and the Krasnyy Vyborzhets Association. Brigades of ministry specialists are at all these enterprises to provide practical assistance in eliminating the shortcomings.

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## NEW OXYGEN-FIRED NONFERROUS METAL PRODUCTION TECHNOLOGY

Moscow MOSKOVSKAYA PRAVDA in Russian 10 Feb 1987 p 1

[Article by N. Lazarev: "The Future of Nonferrous Metals: It Was Done for the First Time"; first paragraph is MOSKOVSKAYA PRAVDA introduction; text in slantlines printed bold in original]

[Text] /The country's largest mining and metallurgical combines are beginning to introduce a new technology, developed by specialists at the Moscow Steel and Alloy Institute, for producing nonferrous metals./

The old engraving depicts a scene: in the center, a huge fire; several people are blowing air into it through bellows and tubes. This is how they made copper -- one of the first metals that people learned to recover from oxygen compounds found in the ore. In this drawing, the most "modern" of its time, the fire was already surrounded by low walls. They gradually increased in height -- and the shaft furnace was created.

Centuries separate us from the ancient fires. However, with each decade, nonferrous metals are just "conquering" new sectors of the national economy: now they are used even in the leather and textile industries, in production of artificial silk and canned goods, minerals, and electrical engineering. And, as before, cobalt, lead, copper, and tin are found in atomic reactors and vessels, decorations and refrigerator parts, plant equipment and sculpture.

Speaking of the new nonferrous metal production technology developed at the Institute, specialists without fail add the words "the most modern" and "the most economical." Indeed, as results of operating the first field prototypes of the units have shown, this method is very promising. Foreign nonferrous metal enterprises have not become interested in this technology by accident.

For the past two decades, the country's mining and metallurgical combines have been basically building furnaces which do not need traditional coke, gas, and electricity -- they run on oxygen. The new method also belongs to the category of energy-saving, autogenic processes, but represents a qualitatively new technological approach and new configuration of equipment.

The new setup is very compact, and at the same time it can replace ten traditional furnaces of equal size in terms of output. This produces an economic effect of tens of millions of rubles. This number will increase as, in the next few years, the industrial giants of nonferrous metallurgy such as the complexes in Norilsk and Balkhash, the Central Urals Copper Smelter not far from Sverdlovsk, and the Irtyshk Works switch to the new technology.

When they were developing it, scientists focused on reducing energy expenditures, increasing the completeness of raw material use, and more completely extracting valuable ingredients.

"An important detail: Our technology, unlike existing ones, permits a much higher moisture level in ore concentrates," says V. Tsesarskiy, head of a sector of the Department of Heavy Ferrous Metals at the Institute for Steel and Alloys. "This is a considerable savings in drying. The charge does not have to be turned into dust; it only has to be crushed into fine lumps. The process in the unit is continuous. The entire mass inside the furnace is molten, and the oxygen-air mixture is added at high pressure. A great deal of heat is released during oxidation. Therefore, the required temperature is always maintained in the melt. Naturally, this technology's advantages include a high level of operation automation and mechanization, which makes metallurgists' work much easier."

Man has gradually expanded the list of nonferrous metals he needs: to red copper he added shiny tin; to grey-blue lead he added silvery cobalt. In every century scientists have proposed previously unknown, advanced methods to mine them and extract them from ore. And the new technology is the first stage in the tomorrow of nonferrous metallurgy of the 21st century.

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# HARDENING OF ALUMINUM ALLOY DRILLING PIPE DURING USE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2, Feb 87 pp 39-42

[Article by M. S. Danelyants, Ye. K. Kichayev, A.S. Neymark and G.M. Fayn, Kuybyskev Polytechnical Institute, Kuybyshev Construction Engineering Institute, All-Union Scientific Research Institute for the Development and Use of Petroleum Industry Pipe]

[Abstract] Laboratory tests were performed to compare the mechanical properties of pipe as delivered under tension and long-term strength parameters. Laboratory specimens were cut from pipe of the same standard type and size, manufactured from a single melt and heat treatment with identical degree of drawing during pressing and known aging conditions. Analysis of the field conditions indicates that the elevated temperatures in the drill pipe string create favorable conditions for artificial aging of aluminum alloy pipe in the field. Field aging differs from laboratory aging in that tensile stresses are applied as the pipe is used. Hardening of the pipe is found to occur over a broad range of temperatures, 160-190°C, and holding times, 8-72 hours. The increase in yield point can be as great as 21% under favorable conditions, with a decrease in ductility of 3-5%, indicating the need for aging under milder conditions to preserve ductility while maximizing yield point. Aging of pipe under stress accelerates the process of phase transformations in the material. References 8: 7 Russian, 1 Western (in Russian translation).

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UDC 620.164.3:669.715

TEXTURE OF ALUMINUM ALLOY PIPE WITH INTERNAL TIPS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2, Feb 87 pp 42-45

[Article by L.S. Kagan, V.I. Ivanova, G.M. Fayn, I.A. Belyashova and S. Yu. Klepachevskaya, All-Union Scientific Research Institute for the Development and Use of Petroleum Industry Pipe]

[Abstract] A study is presented of the influence of texture arising during manufacture and heat treatment of pipes with variable cross section made of aluminum alloy on their mechanical properties. The study was performed on drill pipe 147 mm in diameter using a DRON-2.0 diffractometer in molybdenum $K_\alpha$ radiation. Specimens were cut from the pipe tips and tensile and torsion strength tested at high temperatures. Torsional strength at normal temperature was practically the same for all specimens, while short-term tensile strength and yield point differed significantly. As the density of <011> planes increased, short-term strength also increased. An increased density of <011> planes means that the crystallographic (011) planes have preferential orientation in the plane of pressing. These (011) planes have greater resistance to tensile deformation than any other except the (111) planes, not seen in the pressing planes of based-centered cubic metals. The density of <011> planes is thus a qualitative indicator of structural strength. References 5: 4 Russian, 1 Western (in Russian).

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MULTIPLE SHAPE-MEMORY ACTUALIZATION IN TiNi ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2, Feb 87 pp 49-55

[Article by M.L. Bernshteyn, B.P. Khasenov and U. Khasyanov]

[Abstract] Results are presented from a study of the influence of plastic deformation by drawing, subsequent softening heating and final thermal cycling without load on the mechanical properties, temperature and force-deformation parameters of a Ti alloy containing 49.5% Ni. The change in deformation parameters of the shape memory effect in the process of thermal cycling under load was also studied. All studies were performed on wire specimens 0.2 mm in diameter. The change in deformation parameters during thermal cycling under load through the martensite conversion interval was found to be determined by the tendency of the alloy to so-called martensite conversion creep. Deformation hardening helps to increase the yield point of the matrix, preventing develoment of thermoelastic martensite conversion and thus suppressing the tendency toward martensite conversion creep in the alloy, displacing the martensite conversion interval downward in temperature

and decreasing shape memory. Subsequent softening restores shape memory. The optimal softening temperature is 450-500°C. The parameters are stable with $10^4$ cycles of heating and cooling at 300-400 $N/mm^2$ stress. References 12: 11 Russian, 1 Western.

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NONFERROUS ALLOYS FOR MOTOR VEHICLE CASTINGS

Moscow LITEYNOYE PROIZVODSTVO in Russian No 2, Feb 87 pp 12-14

[Article by Candidate of Technical Sciences A.A. Andrushevich]

[Abstract] Figures illustrate trends in the use of copper alloys, glass, aluminum alloys, plastics, cast iron and steel in motor vehicle manufacture worldwide, indicating that about 7% of the mass of a typical vehicle in 1980 consisted of nonferrous metals, including 5% aluminum alloys. Alloys most typically used in the motor vehicle industry are listed and briefly described. Their mechanical properties are not great, although casting qualities are good. The use of aluminum alloys with better mechanical properties should be expanded, as well as alloys of Mg and Zn. Expanded use of nonferrous cast alloys will require improvement in the quality of motor vehicle castings and their usage characteristics under heavy loads, particularly at low and high temperatures. Complete refining, modification, alloying and directed synthesis of casting alloys and the use of progressive casting methods such as pressure casting and liquid stamping will allow a significant increase in the variety of motor vehicle light alloy castings with superior technological and usage characteristics. References 5: all Russian.

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INFLUENCE OF HOLDING TIME OF MELT ON MECHANICAL PROPERTIES OF AMKh-605 ALLOY

Moscow LITEYNOYE PROIZVODSTVO in Russian No 2, Feb 87 pp 32-33

[Article by Engineer T.B. Kargapolova, Candidates of Technical Sciences I.N. Ganiyev and O.N. Semenova, and Engineer V. V. Beresnev]

[Abstract] A study is made of the influence of refining, introduction of Zr and holding time of the melt in the production furnace on the mechanical properties of AMKh-605 high-strength aluminum alloy, which contains Cu, Cr, Mn, Ti and Zr, in the cast and heat-treated states. After introduction of zirconium to the melt, a specimen was cast each 40 minutes. Eight parts were produced in all. The parts were heated in a furnace with forced air circulation at 540 ± 5°C for 20 hours, hardened in water and aged at 240°C

for two hours. The tests showed that refining of the alloys improved the mechanical properties. Introduction of zirconium had no great influence on tensile strength but increased elongation both in the cast state and after heat treatment. The microstructure of the specimens included a finer grain after treatment with potassium fluorozirconate.

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INFLUENCE OF YTTRIUM ON PROPERTIES OF HIGH-SILICON ALUMINUM ALLOYS

Moscow LITEYNOYE PROIZVODSTVO in Russian No 2, Feb 87 pp 33-34

[Article by Engineer A.I. Gavrilov, Candidates of Technical Sciences A.A. Anikin and K.I. Vlaskina and Engineers Ye. I. Gurevich and M.A. Ismailov]

[Abstract] A study was made of the influence of various yttrium contents on the structure, mechanical properties and workability of aluminum casting alloy AK21M2.5N2.5. Effectiveness of modification of the alloy was estimated by studying the structure, mechanical properties and machinability of the end surfaces of specimens. A 3% aqueous HF solution was used to determine the microstructure. The dimensions of hypereutectic silicon crystals were measured by the method of random cross-sections. Mechanical properties were determined on specimens cut from piston blanks. The optimal quantity of yttrium added was 0.04-0.06%, 0.7-0.1% resulting in properties worse and structure more coarse than in unmodified specimens. This is due to the formation of chemical compounds with the major alloy components, so that the yttrium no longer acts as a modifier at these percentages. Tool life when machining modified pistons increased by a factor of 2-3, tensile strength was greater by 14-18%, hardness HB100-110, wear resistance 30-50% higher. This modification technology is now in use for mass production of pistons, increasing operating life from 6000 to 8000 hours.

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# THERMAL STABILITY OF CERMET USED FOR PROTECTIVE LINING OF MOLDS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 12, Dec 86 (manuscript received 21 Jun 85) pp 86-89

[Article by G.Sh. Kiriya, Yu.K. Bunina and A.V. Sotsenko, Dnepropetrovsk Institute of Metallurgy]

[Abstract] A laboratory study of the cement formed by cast iron and corundum for protective lining of steel casting molds was made, the purpose being to determine the effect of active additives on its thermal stability. Specimens of this material were produced from powders of No. 20 electrocorundum and cast iron containing 4.26% C, 0.58% Mn, 0.71% Si, 0.084% P and 0.27% S. Considered as active additives were FeSi75 ferrosilicon, FeA130 ferroaluminum, FeCr006 ferrochromium, FeMn0.5 ferromanganese, FeMo2 ferromolybdenum, FeB0 ferroboron, also Fe+ 30% Ni and Fe+ 30% Cu alloys with a grain size one order of magnitude smaller than that of the cast iron and the electrocorundum. Each additive was mixed with electrocorundum in a 1:10 volume ratio except ferroboron, which was added in various amounts so as to make the mass of boron equal to 0.1-0.5% of the mass of cast iron. The powder mixtures were vibrationally compacted while being poured into quartz flasks for processing in a SUOL-0.25/12.5-I1 electric furnace, where they were heated to 1250±5°C at a rate of 25-30°C/min and then cooled at 0.5-0.7°C/min through the 1160-1145°C crystallization range, at 0.8-1.0°C/min through the 1145-725°C pre-pearlite transformation range, and at 10-15°C/min to room temperature. Special specimens were tested through 25 thermal cycles simulating the operation of large molds: fast heating from 70±10°C to 800±5°C followed by holding at 800±5°C and then air cooling back to 70±10°C. The thermal stability was estimated on the basis of qualitative structural changes as well as quantitative mass, volume, density, anad diameter changes. Macrostructural examination of the cermet was done under a microscope with x20 magnification. Microstructural examination of the cast iron was done on the basis of graphite and metal oxidation. Density measurement was done by the hydrostatic method of weighing in air and in $CCl_4$. The results indicate that the basic cermet has a 2.3 times higher thermal stability than cast iron and that addition of a ferroalloy increases it further by 15-34%. Most effective is Mn, but alloying with Al, Si, Cr or modifiying with B in adequate amounts is also effective. Alloying with Mo is very effective, but scarcity of this metal makes it less preferable. References 3: all Russian.

2415/9716
CSO: 1842/71

UDC 666.651:621.3.029.5

## A NEW CERAMIC DIELECTRIC MADE FROM TREMOLITE ROCK

Moscow STEKLO I KERAMIKA in Russian No 1, Jan 87 pp 18-19

[Article by V.I. Vereshchagin, doctor of technical sciences, Yu.I. Alekseyev, candidate of technical sciences, and P.I. Shatalov, engineer, Tomsk Polytechnical Institute, Southern Urals Radio Ceramics Plant]

[Abstract] A diopside ceramic was synthesized on a base of calcite-tremolite rock, with additives of 4 to 6 percent Veselov clay, 10 to 12% barium carbonate, and Ulyanov quartz sand. During heat treatment, the amphibole structure was destroyed at 1050°C, and a pyroxene structure formed (revealed by x-ray analysis). The surplus calcite accelerates the breakdown of the tremolite and promotes the formation of a practically pure diopside $CaMgSi_2O_6$. The sintering process was studied by measuring apparent density, water absorptivity, and static transverse strength of the specimens as a function of firing temperature. The intensive sintering interval and maximum apparent density (2.95 to 2.96 $g/cm^3$) were found between 1160° and 1200°C. Strength increased as tremolite concentration in the body rose (190-200 MPa between 1180° and 1200°C). Higher firing temperatures were accompanied by typical signs of overfiring and a drop in strength. Petrographic studies showed that the ceramic has a fine crystalline structure, with most crystals up to 4 μm in size, a few from 6 to 8 μm, and single crystals 20 to 30 μm in size. The vitreous phase was distributed among the crystals in the form of veins up to 2 μm thick. The amount of vitreous phase varied from 28% to 35%. Porosity of the specimens ranged from 6 to 10% with pore sizes from 8 to 20 μm. The diopside ceramic has a maximum firing temperature that is 20° to 30°C lower than its steatite ceramic counterpart, a wider (25° to 40°C) sintered state interval, and 10% to 15% more transverse strength. Its heat resistance is 1.5 to 2 times higher. Articles can be made from this material using conventional technologies and can be substituted for steatite ceramic products. References 2: both Russian.

13050/9716
CSO: 1842/70

UDC 666.762.1:539.32.536.5

## THE ELASTIC PROPERTIES OF STEATITE CERAMICS AT LOW TEMPERATURES

Moscow STEKLO I KERAMIKA in Russian No 1, Jan 87 pp 19-20

[Article by V.L. Ulyanov, candidate of physical and mathematical sciences, and E.V. Pozdeyeva, candidate of technical sciences, S.M. Kirov Polytechnical Institute, Tomsk]

[Abstract] The elastic properties of SK-1 and SNTs steatite ceramics were studied using a two-part piezoelectric resonator within a temperature range of 100 to 300 K. Reference was made to previous articles describing the methods and equipment used to perform the measurements. As the temperature

of the SK-1 was increased, Young's modulus dropped from 120.8 to 115.2 GPa, the shear elasticity modulus dropped from 48.1 to 46.4 GPa, cubic compression from 82.4 to 74.2 GPa, and Poisson's coefficient from 0.256 to 0.233. For the SNTs, Young's modulus declined from 119.6 to 115.3 GPa, the shear elasticity modulus from 48.4 to 46.4, cubic compression rose from 75.4 to 77.1 (220 K), then dropped to 74.6, and Poisson's coefficient rose from 0.236 to 0.243, with a peak of 0.247 at 220 K as the temperature was increased. The data showed that the bonding forces between the structural particles weakened and that these materials do not undergo polymorphic transformations within this temperature range. At room temperature, the density of various specimens was 3072 $kg/m^3$ for the SK-1, and 3020 $kg/m^3$ for the SNTs (using hydrostatic weighing). Although the modulus versus temperature curves are linear for the steatite, MK and GB-7 high-silica, and UF-46 mullite-corundum ceramics, the values of Young's modulus and the shear elasticity modulus for the steatite ceramics are about 3 times smaller than those for the high-silica ceramics, and 2 times smaller than those for the UF-46 ceramic. References 6: all Russian.

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UDC 666.3

EFFECT OF DOPANTS ON PHASE COMPOSITION OF ZnS CERAMIC

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 1, Jan 87 (manuscript received 8 Aug 84) pp 142-144

[Article by Ye.I. Gorokhova, G.V. Ananyeva, and F.K. Volynets (deceased), State of Optics imeni S.I. Vavilov]

[Abstract] The effect of Cu, Al, NaCl dopants on the phase composition of polycrystalline ZnS ceramic with a relative density of 0.995 was studied for determination of its dependence on the sintering temperature. Four grades of ZnS ceramic were tested: "optical"-grade ZnS ceramic, Zn+ 0.053 wt.% $CuCl_2$, Zn+ 0.053 wt.% $CuCl_2$+ 0.05 wt.% NaCl, ZnS+ 0.063 wt.% $CuSO_4$+ 0.063 wt.% $Al_2(SO_4)_3$. They had been produced at temperatures of 1170-1470 K and under a pressure of 196 MPa, with the holding time 60 min and 90 min respectively. The relative fractions of wurtzite and sphalerite were measured in a DRON-2 x-ray diffractometer on the basis of the ratio of integral intensities of reflection by $(10\bar{1}0)$ wurtzite planes and (200) sphalerite planes respectively, taking polarization factors into account. The results indicate that addition of Cu in the form of $CuCl_2$ causes the phase equilibrium shift toward a larger wurtzite fraction of about 0.4 as the sintering temperature is raised from 1170 K to 1270 K and then back toward a larger sphalerite fraction as the sintering temperature is raised further until the ceramic stabilizes into an all-sphalerite structure at 1370 K, evidently owing to precipitation of $Cu_2S$, while the wurtzite fraction in pure ZnS continues to increase beyond 0.8 as the sintering temperature is raised up to 1470 K. Addition of NaCl with $CuCl_2$ was found not to alter this trend, only to slightly boost the wurtzite fraction throughout the 1170-1370 K range of sintering temperature with sphalerite stabilizing correspondingly

at a temperature slightly higher than 1370 K. Addition of Cu and Al in the form of sulfates was found to cause the wrutzite fraction to increase continuously over the entire range of sintering temperatures, just as in the case of pure ZnS but with higher levels from 1170 K, till its stabilization at about 0.6 at a sintering temperature slightly higher than 1370 K. These changes in the phase composition with change of the sintering temperature are accompanied by changes in the radiation emission spectrum of the ceramic as well as in its color, appearance of a blue emission line with $_{max}$=460 nm wavelength being an indicator of Cu precipitation from ZnS in the form of $Cu_2S$. References 9: 6 Russian, 3 Western.

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UDC 666.3

SPECTRAL AND LUMINESCENCE CHARACTERISTICS OF ACTIVATED QUARTZ CERAMIC

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 1, Jan 87 (manuscript received 21 Mar 85) pp 145-147

[Article by V.V. Kornev, I.A. Pavlova and S.S. Pivovarov]

[Abstract] An experimental study was made concerning modification of the spectral characteristics of synthetic $SiO_2$ quartz ceramic, an efficient diffuse reflector of ultraviolet radiation within the 300-1100 nm wavelength range for use in laser systems, by its activation with oxides of rare-earth elements (Ce, Sm, Eu) and other metals (Al, Mn) for the purpose of converting the absorbed ultraviolet pumping radiation into luminescence within the visible range. Specimens of this quartz were activated during the initial processing stage, by concurrent precipitation of polysilicic acids and hydroxides of activator elements during hydrolysis of salts of these elements in tetraethoxysilane and alcohol solutions. Further processing included grinding, dross buildup, casting into molds, drying, annealing, machining, and surface flashing. The concentration of activators was varied over the 0.1-2.0 wt.% total: $Ce_2O_3$ alone or with $Al_2O_3$, $Sm_2O_3$ alone, $Eu_2O_3$ with $Al_2O_3$ or with $Al_2O_3$ and MnO. The spectra of diffuse reflection were recorded in an SDL-1 spectrograph, upon excitation of $SiO_2$<Ce,Eu> specimens at the 313 nm wavelength and of $SiO_2$<Sm> specimens at the 365 nm wavelength by a DRSh-50 mercury-arc lamp through a DMR-4 monochromator. The spectra of diffuse reflection reveal that the reflector efficiency decreases with increasing activator concentration, but decreases much less when $Al_2O_3$ or $Al_2O_3$ + MnO present. Scattering of radiation is decreased and its diffuse reflection is increased by $Al_2O_3$. which homogenizes the vitrified layer while it shifts the absorption band toward shorter wavelengths. The dependence of diffuse reflection at the 550 nm wavelength on the thickness of the vitrified layer confirms the beneficial effect of $Al_2O_3$ and especially of 1.5 wt.% $Al_2O_3$ + 0.4 wt.% MnO, which causes the reflection coefficient to remain nearly constant (about 0.9 with 1.5 wt.% $Eu_2O_3$) as the layer thickness increases even beyond 4 mm. References 5: 4 Russian, 1 Western.

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UDC 539.21.213+666.3

# ELECTRIC MATERIALS BASED ON FERROELECTRIC CERAMIC AND GLASS COMPOSITES

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian
Vol 23, No 1, Jan 87 (manuscript received 28 Feb 84) pp 148-151

[Article by E.Zh. Freydenfeld, R.Z. Kleyne, Ye.M. Panchenko, T.V. Sokolova and V.A. Zagoruyko, Scientific Research Institute of Physics, Rostov State University imeni M.A. Suslov]

[Abstract] The electrotetic state in inorganic composite polarized materials, specifically $PbTiO_3$-$PbZrO_3$ ceramics with lead glasses, is evaluated for a refinement of the "like injected charges - unlike space charges" model. A special refractory Bi-Pb-Ti glass having a density of 5.18 g/cm$^3$, a dielectric constant of 21, and an electrical conductivity of $10^{-12}$ S/m at room temperature (290 K) was developed for the experiment, compactness having been ensured by adequate chemical affinity between amorphous glass and crystalline ceramic as well as adequate wettability of the ceramic by molten glass during annealing at temperatures of 970-1470 K for periods of time ranging from 3 min to 1 h. Nine specimens with the volume fraction of this glass ranging from 0 to 1 were tested for electretic potential difference and effective surface charge density over a relaxation period of 30 min to 5000 h after polarization. Composites with 10-30 vol.% glass were found to be most effective. A theoretical analysis of the data has revealed that the Maxwell-Wagner polarization mechanism of a double-layer capacitor does not fit here. Measurement of the thermocurrent in these composite materials has yielded a maximum thermocurrent at a temperature within the glass softening range. The appearance of smaller new thermocurrent peaks within the much lower 600-800 K temperature range as the volume fraction of glass is increased rules out destruction of the composite and indicates formation of additional charge carrier trapping centers in it, with resulting almost complete compensation of the space charge by the injected charge. The electrotetic state will accordingly be most stable in composites consisting of a crystalline ceramic with electronic conductivity and a glass with ionic conductivity. References 4: all Russian.

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UDC 621.762.242

# REDUCTION OF COMPLEX Fe-Ni-Co OXIDES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Dec 86 (manuscript received 27 May 86) pp 1-7

[Article by L.Ye. Sarkisyan, Yerevan Polytechnical Institute]

[Abstract] An experimental study of complex Fe-Ni-Co oxides was made to determine the kinetics of their reduction and possible mechanism of alloy formation. Binary ferrite $CoFe_2O_4$ as well as binary solid solutions $Co_xFe_{3-x}O_4$ and ternary solid solutions $Ni_xCo_yFe_{3-x-y}O_{4\pm\delta}$ were considered, stoichiometric analytically pure powder mixtures being synthesized with addition of 4 wt.% $NH_4Cl$ at a temperature of 1110°C for 3 h and peroxide NiO-CoO powder mixtures being baked at 1000°C for 2 h. They were reduced in two ways, polythermally with carbon soot and isothermally with hydrogen, the reduction process being tracked respectively with a Q-1500D derivatograph and by thermogravimetric analysis. The phase composition of crystalline reaction products at successive stages of the process was determined on the basis of structural examination in a DRON-2 x-ray diffractometer. The results and analysis of chemical reactions occurring in mechanical mixtures of such oxides indicate that each oxide is reduced separately. An exception is a mixture of $Fe_2O_3$ and CoO, which partially react forming $CoFe_2O_4$ when heated together with carbon soot. At temperatures below 572°C reduction takes place by the mechanism of ion displacement on the outer surface. At temperatures above 572°C volume diffusion causes partial reduction of trivalent Fe ions to bivalent Fe ions, which displace Co ions or both Co and Ni ions so as to form magnetite. The latter is then reduced in two stages to metallic iron. Complete reduction of oxide mixtures results in a continuous series of metallic solid solutions and the end products are homogeneous Ni-Co alloys. References 11: 9 Russian, 2 Western (1 in Russian translation).

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UDC 621.726

CONDITION FOR PLASTICITY OF HARD-ALLOY POWDER MIXTURES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 86 (manuscript received 21 Jan 86) pp 11-15

[Article by Ya.Ye. Beygelzimer, A.P. Getmanskiy and L.I. Alistratov, Donetsk Institute of Engineering Physics]

[Abstract] The condition for plasticity of hard-alloy powder mixtures is derived theoretically from the general conditions $p^2/\psi(\theta) + \tau^2/\phi(\theta) = (1 - \theta)k^2$ (p- hydrostatic macropressure, $\tau$ - macrostress deviator, k- microstress deviator) applicable to any powder, with $\psi(\theta)= 2(1- \theta)^3/3\theta$ and $\phi(\theta)= (1- \theta)^2$, considering that powders of hard alloys consist essentially of many hard and brittle carbide grains with few plastic filler grains. In this case k depends on the pressure: $k= k_0$ when $k_0+ \alpha p > k_m$, $k= k_0+ \alpha p$ when $0 < k_0+ \alpha p \leq k_m$, $k= 0$ when $k_0+ \alpha p \leq 0$ ($k_0$- shear bonding constant, $k_m$- maximum shear strength of carbide grains, $\alpha$ - coefficient of internal friction). This condition was verified indirectly on various W-Co alloy powders with (6-20) % Co, in an experiment under hydrostatic compression so that $\tau = 0$. An evaluation of the results has revealed that $\alpha$ decreases and $k_0$ increases with increasing Co content. The authors thank A.M. Laptev and I.A. Leonov for helpful discussions. References 4: all Russian.

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CSO: 1842/75

UDC 541.124+546.817-31'824-31+537.228.1+66.040.36

PRODUCING $PbTiO_3$ AND ITS SOLID SOLUTIONS FROM OXIDES IN NaCl + KCl MELT

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 1, Jan 87 (manuscript received 2 Apr 85) pp 117-122

[Article by S.S. Lopatin, T.G. Lupeyko, T.I. Ivleva, B.S. Medvedev, T.S. Protasenya and L.M. Lobas, Rostov State University imeni M.A. Suslov]

[Abstract] The mechanism and the kinetics of $PbTiO_3$ formation from PbO and $TiO_2$ oxides in a melt of equimolar NaCl+KCl salt mixture was studied, using "capacitor"-grade $TiO_2$ of the rutile variety and 0.05-0.2 μm grain size fraction with chemically pure PbO, NaCl and KCl. The powder product was poured into porcelain crucibles for sintering in a muffle furnace at 700-800°C, then washed with water for removal of chlorides. It was subsequently analyzed for $PbTiO_3$ content by filtration and titration, first with Trilon B in $CH_3COOH$ as buffer and then with $H_2SO_4$ concentrate to which $(NH_4)_2SO_4$ was added during heating. Phase anlaysis was performed in a DRON-2.0 x-ray diffractometer with a $CuK_\alpha$-radiation source. PbO and $TiO_2$ disks 5 mm apart and parallel faced were immersed in a salt melt at a temperature of 800°C for 1.5 h. X-ray phase analysis revealed a buildup of

$PbTiO_3$ on $TiO_2$ ceramic, indicating a unilateral migration of PbO to $TiO_2$. An analysis of the kinetics of this process at a temperature of 700°C on the basis of time normalization and the Jahnder equation, which best describes the entire experimental curve, reveals that diffusion of PbO through the intervening layer of salt melt is the limiting stage. Powder produced in a salt melt was found to constitute a pure perovskitic phase, while powder produced without a salt melt was found to contain also a fluoritic phase. The highest yield of ceramic material from oxides, up to 99%, was obtained by synthesis of powders in a salt melt at temperatures above 750°C. Piezoelectric properties were measured after polarization in silicone oil by an electric field of 50 kV/cm intensity at a temperature of 150°C for 30 minutes. The ceramic product was found to have a high ratio of thickness-to-radial electromechanical coupling coefficients. Dielectric permittivity and loss tangent were measured on a VM-484 bridge at a frequency of 1.6 kHz, thermal expansivity was measured in an automatic quartz dilatometer. The authors thank I.N. Tyumenev, L.A. Derbaremdiker, A.M. Polonskaya, L.A. Lisutin, and V.B. Nalbandyan for their assistance.
References 10: 1 Russian, 9 Western.

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COOLANT-LUBRICANTS UNDERUTILIZED IN MACHINE BUILDING

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 17 Jan 87 p 2

[Article by M. Bugayets, assistant professor, Lvov Polytechnical Institute, under the rubric "Reserves of New Technologies": "If You Don't Grease the Wheels, You Won't Get Anywhere"; first paragraph is SOTSIALISTICHESKAYA INDUSTRIYA introduction; text in slantlines printed bold in original]

[Text] Lvov--/No, we aren't talking about bribes. We have another aim: robbing the proverb of its metaphorical meaning, we will use it to look at certain problems of traveling on the path of scientific-technical progress./

In the articles "Demand for Wear" (5 March) and "Whom to Ask for Wear" (4 July 1986), SOTSIALISTICHESKAYA INDUSTRIYA raised the important question of the widespread use of metal-cladding lubricants which make assemblies and parts wear-free during friction. If only we had to contend just with friction in machinery production and operation! If only our equipment lacked just metal-cladding lubricants! The colossal capacities of metal-cutting equipment and tools, i.e. the foundation of all machine building, experience a constant, insatiable hunger for effective SOZh [liquid coolant-lubricants].

...Seven years ago scientists from our polytechnical institute went to the shops at Lvov's Avtopogruzchiki Association to check the effectiveness of their developments in practice. The results shocked even the specialists. For example, in drilling 32-mm-diameter holes in parts made of steel 40 Kh, the tool went without resharpening for 8 shifts, while it had to be resharpened 3-4 times per shift before! High results were also obtained in gear-cutting, drawing, knurling, and in machining carbon and high-alloyed steels. The new polymer-containing coolant-lubricants proposed by the scientists brilliantly passed the test.

But it was a little early for the scientists to celebrate the victory. When it was a question of the future reduction in cutting tool consumption and the possible revision of norms and remuneration rates, Avtopogruzchik specialists rejected the progressive innovation.

The experiment at ZIL [Plant imeni Lenin] went somewhat differently. Good results were also obtained there. Test reports recorded that cutting tool

life increased 50 to 300 percent, electricity consumption fell, and machining finish improved. The ZIL workers went farther than their colleagues in Lvov and even signed a joint document in which they recorded their desire to replace ineffective process emulsions with more progressive coolant-lubricants. They began talks with the Rostov Experimental Petroleum-Oil Plant on switching to production of new goods. In a word, a little more, just a bit more.

But this wasn't enough. The Rostovians were ready to supply machine builders with the oils they need, but in exchange, they asked for share participation in the reconstruction of their production facilities. Unfortunately, the Ministry of the Automotive Industry and ZIL personnel were not ready to demonstrate flexible economic thinking and invest in a related sector. The interdepartmental correspondence which had begun quickly ceased, now pointless. And everything was as before.

There was an attempt to solve the problem on the regional level. In 1980 B. Yatsiv, director of the Lvov Petroleum Refinery, evaluated the scientists' developments and organized serial production of liquid oils and emulsions for the coal industry. But the director's energies and wishes were not enough: additional capacities and equipment were needed if only to supply Lvov enterprises with the new product. And neither could be had.

One asks, perhaps these new coolant-lubricants were really not so necessary. What won't scientists think up? Let us turn to summaries. Use of Avkol, Ukrinol, MKhO, MR and OSM series coolant-lubricants in cutting various engineering materials increased feed rate 20-40 percent, while the tool's service life was maintained. The life of hard-alloy and high-speed cutting tools increases two- to fivefold. Energy consumption drops by one-fourth. Machining quality and operator working conditions improve. Overall, the improvement in the entire set of technological characteristics gives an additional 1.5-time boost to labor productivity!

Are the machine building ministries familiar with these figures? Of course. Then what's the matter? Machine builders were accustomed to dealing with process means which had virtually no effect whatsoever on either labor productivity or part quality. They used them when dry cutting was simply impossible or strictly controlled by the machining routes.

The machine builders' passive attitude toward coolant-lubricants as a factor in intensification is understandable, and they have passed it on to oil refiners. Moreover, in the system of the USSR Ministry of the Petroleum Refining and Petrochemical Industry, process means for cold machining of metals are under the low-volume output section. As a result, the developers turned out to be the ones most interested in implementation.

It's difficult to understand the position which the USSR State Committee for Science and Technology has taken on this issue. In the past two five-year plans, the All-Union Program for Creation and Introduction of Efficient Process Media in Machine Building has been functioning under the Committee's aegis. This program united most machine building ministries, branch

institutes, USSR Ministry of the Petroleum Refining and Petrochemical Industry subdivisions, the USSR Academy of Sciences, and institutions of higher learning. As noted above, a good deal was done under this program. But 1986 and the five-year plan for intensifying production began, and the State Committee eliminated the program. Only a tiny section related to providing coolant-lubricants required for flexible automated systems remained.

Coolant-lubricants can be produced from secondary raw material and production wastes. Scientists at the Lvov Polytechnical Institute have developed high-efficiency coolant-lubricants based on wastes from the cellulose-paper and leather industries and products from polymer stock reprocessing. There are promising developments at other scientific centers in this country. But their fate is similar: gathering dust on the shelf.

This is briefly how travel on the train of scientific-technical progress looks. As much as we would like to oil the wheels, there's still nothing to do it with! So where is the way out?

It's time to move from debates between machine builders and chemists to action. A great deal depends on user activism. In our opinion, certain branches which are major users of coolant-lubricants and have chemical enterprises within their own structures should set up production themselves. Wherever this is impossible, machine builders might seriously help chemists by supplying them with materials and structures and in creating the required units. It's time to move from neutrality and temporizing to active collaboration.

And who will take charge of this work? The State Committee for Science and Technology, of course. If it will resurrect the previous goal-oriented program. We are not talking trifles, but about a tremendous increase in labor productivity in machine building. And, with minimum expenditures.

12809
CSO: 1842/88

UDC 669.14.018.298.3

# IMPROVING OVERALL QUALITY OF 37CrNi3N$_2$ STEEL BY DOUBLE QUENCHING

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 12, Dec 86 (manuscript received 28 Dec 84) pp 64-67

[Article by L.G. Vlasova, S.S. Chernyak, V.L. Ivakin and L.I. Kazantseva, Irkutsk Institute of Railroad Transportation Engineers]

[Abstract] Double quenching of 37CtNi3N$_2$ structural steel as a method of improving its composite mechanical characteristics was studied, first quenching from 950°C followed by tempering at 580°C and second quenching from 850°C followed by tempering at 200°C having been found to be the optimum mode of treatment for increasing yield strength, ultimate tensile strength, and fatigue resistance without decreasing plasticity and toughness. For comparison, mechanical tests including hardness measurement were also performed after single quenching and after double quenching without intermediate tempering. Final low-temperature tempering at 200°C, moreover, was found to increase percentage elongation to 12%, percentage reduction to 57%, and toughness under impact to 0.5 MJ/m$^2$. Double quenching was also found to improve the mechanical characteristics of this steel at temperatures down to -60°C, maximum improvement being attained by high-temperature intermediate tempering at 580°C. This highly favorable effect of double quenching is attributable to comminution of the austenite grain. The grain size is always smaller after double quenching than after single quenching from the same temperature, the difference increasing with higher quenching temperature, because single quenching promotes dissolution of the carbide phase and subsequent buildup of the austenite grain while the second quenching evidently causes recrystallization of the thus precipitation-hardened austenite after intermediate tempering has produced a substructure with many interstices available for nucleation of martensite grains.

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UDC 546.48

MORPHOLOGICAL CHARACTERISTICS OF HgTe CRYSTALS ANNEALED BY LASER PULSES

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 23, No 1, Jan 87 (manuscript received 4 Apr 85) pp 42-47

[Article by A.A. Zaginey, B.K. Kotlyarchuk, I.V. Kurilo, Z.O. Kushnir and G.V. Savitskiy, Institute of Applied Problems of Mechanics and Mathematics, UkSSR Academy of Sciences]

[Abstract] An experimental study of annealing HgTe crystals with laser pulses was made, its object being structurization of the surface layer during this process. Specimens of HgTe single crystals in the form of 1 mm thick and 4x4 $mm^2$ large wafers were mechanically ground with abrasive powders and polished with diamond pastes, then chemically etched with an 8% methanol solution of bromine and rinsed with a 30% methanol solution of $H_2O_2$. The surface finish was monitored in an EMR-100 electron diffractometer. They were annealed, at room temperature or after preheating at 350-400 K, with a GOS-301 neodymium laser emitting solitary pulses of 1.5 ms duration with an energy varied over the 0.2-15 $J/cm^2$ range. Their microstructure within the laser action zone was examined under "Metalloplan" metallographical microscope in obliquely incident light. Elemental and phase content of the surface layer was determined with a "Camebax" electron-probe x-ray spectral microanalyzer. With probing radiation from a He-Ne laser, a time scan of its intensity was used for monitoring the fusion and recrystallization dynamics. The results reveal three different modes of pulsed laser action on the HgTe surface layer within corresponding three characteristic ranges of pulse energy density: chemical purification by weak laser pulses with 0.2-1.5 $J/cm^2$ energy density; melting and partial vaporization by intermediate laser pulses with 2.5-5.5 $J/cm^2$ energy density followed by recrystallization into a cellular or columnar structure; and preferential varporization by strong laser pulses with 6-15 $J/cm^2$ energy density, causing surface ablation and embrittlement to a microhardness of up to 0.9 GPa (initial microhardness 0.28 GPa) as a result of thermal stresses and loss of Hg. References 10: 7 Russian, 3 Western (1 in Russian translation).

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UDC 621.785.6.06

USE OF POLYMER HARDENING MEDIA FOR HARDENING OF PARTS OF TYPES 40KhN AND 35KhGSA STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2, Feb 87 pp 6-9

[Article by A.A. Kats, M.M. Rozin, E.Ya. Markus and N. Ya. Kudryavtseva]

[Abstract] A study is made to determine the possibility of using polymer hardening media for hardening by quenching of a number of parts. The media tested were aqueous solutions of polyacrylamide (PAA), hypoferrous salt of

polyacrylic acid (PK-2) and polydimethyldiallyl ammonium chloride (VPK-402). The cooling capacity of the media was tested by cooling of silver balls. The results indicated that PAA should not be used for hardening, since in both 0.3- and 0.4% solutions the cooling rate in the pearlite interval is less than in oil, whereas that of PK-2 is greater than oil, and VPK-402 is closer than the other media tested to the cooling rate of oil. VPK-402 is a class three or moderately toxic compound and can be recommended for industrial use. Tests under plant conditions achieved positive results. Hardening of parts of type 40KhN, 40Kh and 35KhGSA steels in PK-2 solutions at 0.6-1.2% concentration, and in VPK-402 at 2.0-3.0% concentration, temperatures 20-80°C, produced the necessary hardness with no cracks and the required combination of mechanical properties. References 5: all Russian.

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CSO: 1842/90

UDC 621.785.616.2:669.14.018.298.3

MULTISTAGE HARDENING AS A METHOD OF INCREASING THE STRUCTURAL STRENGTH OF TYPE 42Kh2GSNM STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2, Feb 87 pp 9-11

[Article by A.A. Mikheyev, V.K. Vilkov, N.P. Melnikova and M.I. Bannova]

[Abstract] A study is made to select hardening for a massive flange of steel type 30Kh2GSNVM to which a base of sheet steel type 42Kh2GSNM 2 mm thick was welded to increase the structural strength of the base. The structural strength of the steel of the base was found to be highly sensitive to the hardening mode. The influence of aging time of the austenite at 600 and 450°C on its transformation during subsequent cooling was therefore studied. Multistep hardening at 430-470°C did not improve the structural strength of the steel. Multistep hardening is recommended with holding at near the lower boundary of the pearlite area for no greater than the incubation period of the formation of carbon-enriched zones in the austenite, since such zones are transformed upon subsequent cooling to a carbide phase. References 6: all Russian.

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# IMPROVING THE DESIGN OF THE BRAZED JOINTS IN THE STATOR WINDING OF HYDROELECTRIC GENERATORS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 1, Jan 87 pp 2-3

[Article by M.M. Chernomorskiy, engineer, A.P. Korsakov and S.T. Poplaykhin, technicians, the scientific research institute of the Sibelektrotyazhmash [Siberian Heavy Electrical Machinery] Plant, Novosibirsk]

[Abstract] The mechanical design of a hydroelectric stator winding and the procedure for brazing its parts together are described. Resistance brazing was employed, with graphite electrodes mounted on the nozzle of the component in C2 clamps. The shaft of the stator winding consists of 20 solid 2.5 x 9.5 mm conductors and 10 hollow 2 x 6.3 mm conductors with wall thicknesses of 1.5 mm. The nozzles, cold-extruded from copper bars, are partitioned into a chamber for the winding shaft and a hydraulic chamber. The hollow conductors pass through rectangular apertures in the partition and extend 28 mm beyond the solid conductors into the hydraulic chamber. A sheet of copper two mm thick is inserted between the two rows of conductors. The shaft and nozzle were brazed together by placing strips of filler metal into the female part of the drainage fitting and allowing the molten filler to flow into the clearances between the walls formed by the aperatures in the partition and the hollow conductors and form two overlapping layers of filler two to three mm thick. A bushing prevents the filler from getting into the hollow conductors. The nozzles were brazed together by their lugs to form the current-conducting assembly, which was braced by an adjustable C-clamp to bring the lugs of the nozzles into alignment with the bushing at the joint. The clamp was fitted at one end with a sharp point that rests against a "little shelf" at the bottom of the nozzle. In the event of thermal expansion, this point pierces the nozzle body and protects the drain fitting from deformation. The busses were made of rectangular copper tubing and fitted with an endpiece made with an electrical junction lug and brazed at a 180° angle to the stator shaft nozzle. The current-carrying connecters were made of copper pipe 40 mm in diameter with a wall thickness of 10 mm. Endpieces were used to join the connecters to the shaft. The joint between the connecters and the drain fittings (copper pipe 26 x 2) was brazed to form a hydraulic and electrical fitting. The hydraulic winding shafts were combined into groups of four using 26 x 2 mm copper connecting pipes. The connecting pieces and drain fittings were torch brazed with PSr15 filler alloy. Monolit-2 thermoreactive insulation was used to prevent damage to winding parts during brazing. This stator winding design is highly reliable. References 4: all Russian.



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BRAZING TITANIUM-GRAPHITE FACE SEALS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 1, Jan 87 pp 5-6

[Article by B.N. Perevezentsev, N.M. Sokolova, Yu.N. Upolovnikov and R.N. Shishkina, engineers, Tolyatti Polytechnical Institute]

[Abstract] The process of brazing VTZ-1 titanium alloy rings to gaskets made of BSG-30 borosiliconized graphite was studied to determine the optimal conditions for making face seals with these materials. A paste made of powdered VPr16 brazing filler alloy (Ti--Zr--Cu--Ni system) was pre-placed in rod form next to the clearances. The binder was a solution of BMK-5 acrylic resin in R5 solvent. Brazing was done in a vacuum using non-titanium boxes as getter screen. Ways to reduce the residual stresses in the joints during the brazing process were studied. The optimal brazing cycle was determined to be: slowly heating the parts up to 880°C, quickly heating them up to 950°C at a rate of not less than 40°/minute, holding the joint for three minutes, furnace cooling down to 700°C, additional cooling down to 400°C at a rate no greater than 1.5°/minute, and final furnace-cooling period. Starting at a temperature of 940°C, the filler satisfactorily wetted and flowed over the graphite. The angle of contact at 940° and 950°C was 23 and 13, respectively. Metallographic analysis and microhardness readings showed that no carbide lamella were formed. To ensure the formation of a high-quality joint, the parts must be fitted very closely (clearance no more than 0.05 mm). To ensure that the filler metal flows well into the clearances, the filler rod is placed in a special groove made for it on the face of the titanium ring. Tests on telescopic specimens showed that failure always occurred along the graphite. The strength of the graphite was 7.5 and 8.3 MP at a cooling rate of 1.5° and 0.75°C, respectively. Seals made using this technology are being tested to ammonia pumps and are performing very well. References 1: Russian.

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USING COLD-RESISTANT COPPER-MANGANESE FILLER METALS TO BRAZE OBJECTS MADE OF 12Kh18N10T STEEL

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 1, Jan 87 pp 6-7

[Article by Yu.F. Shein, engineer, Ye. I. Storchay, doctor of technical sciences, Yu. N. Lantushenko and L.S. Tarasenko, engineers, Kriogenmash (Cryogenic Machinery) Scientific Production Association]

[Abstract] The effect of the conditions under which an object is brazed and utilized on the properties of the joints was studied. The base metal was 12Kh18N10T steel and the filler metal P65 copper-manganese alloy with a liquidus of 910°C. Brazing was done in an SGV 24-2/15 vacuum furnace at a

pressure of $(5\div8)10^{-3}$ P at temperatures of 950°, 1000°, and 1050°C. A galvanic coating of nickel 15 to 25 μm thick was applied to the base metal to improve the filler's ability to wet the base metal and flow into the clearances, which ranged from 0.05 to 0.5 mm. At 1000° and 1050°C, capillary attraction caused the metal to satisfactorily flow into and stay in joints with clearances up to 0.35 (overlapped joints). Shear strength and impact strength were tested on flat and telescopic specimens at 20° and -196°C. The shear strength specimens were tested on an UM-5 machine. The strongest specimens (250 to 361 MPa) were obtained by brazing nickel-coated steel at temperatures of 1000° and 1050°C with a holding time of 15 minutes. Metallographic analysis and microhardness readings showed that there were no brittle phases in the joint metal, which consisted of a solid solution of manganese, chrome, and nickel in copper. The filler alloy flowed completely into the gaps when the clearance was between 0.05 and 0.3 mm and the overlap between 3 and 30 mm. The shear strength tests showed that the technical properties of the joints were virtually unaffected by repeated thermocyclical exposure. The brazing cycle did not lead to the formation of carbides in the metal. Partial anode polarization curves of the zones in the brazed joints and the values for the static potential of the joints in acid, alkaline, and neutral solutions were analyzed to determine the corrosion properties of the joints. The joints were vulnerable to corrosion in the $H_2SO_4$ and NaCl solutions and highly resistant to corrosion in the NaOH solution. The dimensions of the brazed objects were not distorted by the brazing process. References 2: both Russian.

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UDC 621.791.18

## ON THE MECHANISM INVOLVED IN THE INTERACTION OF AMg6 ALLOY WITH QUARTZ GLASS DURING DIFFUSION WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 1, Jan 87 pp 41-42

[Article by V.A. Bachin, candidate of the technical sciences, E.A. Goritskaya and S.D. Lazarev, engineers, Moscow Institute of Aviation Technology imeni K.E. Tsiolkovskiy]

[Abstract] The diffusion welding of quartz glass through foil made from AMg6 alloy was studied. Two welding cycles were tested. In both cycles pressure was 10 MPa and welding time 30 minutes, but the temperature was 530°C in the first cycle and 620°C in the second cycle. Several transitional layers were formed in the joint zone. Microhardness was lowest (600 MPa) in the center of the foil insert and increased to 3,500 MPa at its edges and to 11,000 MPa within the transitional layers, which consisted of very thin zones in which the concentrations of Mg, Si, Al, and $O_2$ diminished. X-ray spectral analysis showed that, in the zone where the glass joins to the alloy, a reaction occurs, wherein aluminum is substituted for silicon, and spinels of $MgO \cdot Al_2O_3$ are formed. The final chemical constitution of the compounds formed by the reaction was determined by comparing shifts in the characteristic curves obtained by recording the intensity of the x-ray radiation for several specimens and

for a standard specimen. The aluminum is irreversably reduced at 500°C or higher to form the $Al_2O_3$. The cation $Mg^{2+}$ acts as a modifier and leads to an increase in the quantity of $O^{2-}$ relative to the $Si^{4+}$ and to the binding of this cation (Mg). When the temperature is increased, a large quantity of the MgO modifier is introduced at the front end of the reaction, and the tetrahedral structure on the $(SiO_4)^{4-}$ base is destroyed, resulting in an increased tendency towards devitrification and a weakening of the glass. References 5: all Russian.

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STRUCTURE AND PROPERTIES OF METAL FROM NEAR SEAM ZONE OF WELDED JOINTS OF HIGH-ALLOY TITANIUM

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2 Feb 87 pp 57-59

[Article by V.N. Mesheryakov, Yu.G. Kirillov and I.V. Lyasotskiy, Metallurgy Institute imeni A.A. Baykov; Central Scientific Research Institute of Ferrous Metallurgy imeni I.P. Bardin]

[Abstract] A study was made of the influence of cooling rate during welding between 0.6 and 600 K/s on the structure and properties of metal near the seam in VT22 and VT23 titanium alloys. For martensite alloys such as VT23, the most favorable combination of strength and ductility was obtained at low and high cooling rates during welding. Ductility decreased and strength increased greatly in the area of cooling rates of 6-30 K/s. VT22 showed little variation of strength with cooling rate, though ductility near the seam was quite sensitive to cooling rate. At 1-15 K/s the metal has low ductility. The optimal combination of strengths and ductility for both alloys is achieved by either high or low cooling rates, avoiding moderate cooling rates. Heat treatment of welded structures is therefore necessary to achieve good mechanical properties in these alloys. References 3: all Russian.

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# RADIO ISOTOPE UNITS DETECT RARE METALS IN ORE AT EAST KAZAKHSTAN PLANTS

Moscow IZVESTIYA in Russian 24 Nov 83 p 4

[Article by IZVESTIYA correspondent V. Shchepotkin, under the rubric "Fact and Commentary": "Treasures from an 'Empty' Rock"; first paragraph is source introduction]

[Text] Of 29 USSR State Prizes awarded in 1985 in the field of technology, two were awarded for the creation of outstanding technology in nonferrous metallurgy. Both developments have the same "place of application" -- East Kazakhstan Oblast. It is precisely there, at the Ust-Kamenogorsk Lead and Zinc Combine and the Zyryanovsk Lead Combine, that highly effective technology, which has no counterpart in domestic or worldwide practice and which is based on the efficient use of polymetallic ores, was tested for a number of years and then introduced.

East Kazakhstan Oblast. The ores of East Kazakhstan contain more than 40 elements in the Mendeleyev table. However, until recently, out of all that wealth, industry has taken only individual elements, basically lead, zinc, copper, gold, and silver. It was simply impossible to extract anything else: the technology did not allow it. The waste products, including the so-called rare metals, those very metals without which it is impossible to create modern technical prototypes or materials with preassigned properties, were just dumped into the tailings.

An attempt to sever this Gordian knot was undertaken by specialists at the Ust-Kamenogorsk Lead and Zinc Combine, in cooperation with scientists from several scientific-research institutes.

The task was a difficult one and had never been resolved by anyone anywhere in the world. It is for good reason that the metals are called rare. In a ton of ore there are only grams of the metals. And not just one particular element, but several: tellurium, indium, thalium, and cadmium.

During their years of searching, the combine's scientists and specialists tested a massive number of methods and technologies until they finally created state-of-the-art production, which makes it possible to obtain, as by-products from the production of the basic metals, the rare metals that were mentioned. The extent to which that production has enriched domestic and foreign practice

is attested to at least by the fact that the innovations developed by the creative collective have been protected by 52 USSR author's certificates and 8 patents issued in capitalist countries.

The startup of the new technology at the Ust-Kamenogorsk Lead and Zinc Combine has increased the complete use of raw-material ores. The combine, which has twice been awarded an Order, has currently "assimilated" a total of 18 chemical elements, making it possible to produce 24 types of commercial output.

Better use of the polymetallic raw materials is also the aim of a second project being carried out by a group of scientists and industrial workers who have created at two combines, including the Zyryanovsk Lead Combine, radio isotope units for automatically determining the quantity of nonferrous metals in the ore even before it is sent to the concentration plants, and then to metallurgical production.

Determining the quality of the extracted mass at the very beginning of the technological chain, so as not to expend efforts and funds on unnecessary transport or for expensive processing of relatively low-value raw materials in the shops of the concentration plants, and, at the same time, improving the quality of the ore by means of preliminary grading is the task that has confronted the miners of many countries for a long time.

Soviet engineers and scientists have succeeded in solving that problem. They created radio isotope units that have no domestic or foreign counterparts. With high accuracy, and automatically, the units determine the quantity of useful components in the polymetallic ore which is being carried in mine cars, dump trucks, and railroad cars, and on conveyor belts. Equipment installed underground at the Zyryanovsk Combine, together with a computer installed on the surface and weight-measurement devices, communication system, and industrial television system, essentially speaking, is in complete control of the technological process.

The automatic radio isotope ore-grading systems are ecologically harmless, mobile, and extremely inexpensive to operate. Their cost is also low: 25,000-30,000 rubles. However, their use during the current five-year plan has yielded a savings of more than 3.5 million rubles. And the introduction of the innovations in the entire polymetallic subsector of USSR Mintsvetmet [Ministry of Nonferrous Metals] promises a saving of no less than 60 million rubles.

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# KAZAKHSTAN PLANTS PRODUCE METALS FROM WASTE PRODUCTS

Moscow PRAVDA in Russian 1 Dec 83 p 1

[Article by A. Petrushov, PRAVDA correspondent, and P. Shchuplov, PRAVDA stringer: "Metal from Tailings: How We Are Fulfilling Our Pledges"; first paragraph is source introduction]

[Text] The republic that is considered the bulwark of Soviet nonferrous metallurgy is Kazakhstan, where a considerable part of the country's production of lead, zinc, copper, titanium, magnesium, and other necessary metals is concentrated. In 1983 the workers in the branch in that republic pledged to exceed the plan for nonferrous metals and alumina by 1.6 million rubles and, simply by bringing substandard raw materials into economic circulation and reprocessing the waste products that were produced in past years, to produce tens of thousands of tons of commercial output. How is the fulfillment of the planned measures proceeding?

Ust-Kamenogorsk, 30. A land of snow-topped mountain peaks, of rushing rivers, and vast areas of taiga -- this is East Kazakhstan, which still is called Rudnyy Altay. The pride of this land is the Ust-Kamenogorsk Lead-Zinc Combine imeni V. I. Lenin. Thirty-five years ago the first lead was produced here, but today the combine produces 28 types of output.

The smelting shop in the lead production area. We ascend to a platform where red-hot furnaces are in operation. A fiery stream is flowing, and the bucket is filling up with black lead. In the refining shop, the "fellow travelers" are removed from the black lead, and the black lead is converted into ingots of blue metal. As a rule, purity here is designated by four nines. The standard of quality!

Communist Party member Yu. Rystov's fifth shift is on duty. Both the foreman himself and his comrades feel that steady work is guaranteed primarily by precise organization of the labor, and by a creative attitude toward the job to be done. People will tell you here that the smelting furnaces have been redesigned and the slag-fuming unit has been improved. Thanks to these innovations, there has been an increase in the efficiency of the machinery and a reduction in the water expenditure. Processing the waste products has provided the opportunity to produce additional thousands of tons of lead, zinc, and copper.

D. Onishchenko, leader of a brigade of smelters, mentioned the advantages of the new organization of labor. His brigade is one that performs all phases of the production process. In his opinion this consolidates people and forces them to seek inner reserves and to save time and resources. For example, it has been possible to reduce the copper content in the slag to a minimum, and to save 65 tons of standard fuel. Today the combine has a rather large number of well-coordinated collectives like this, which are striving to produce more output with smaller expenditures of manpower and means.

"In addition to the basic components, we extract 14 useful ones," A. Kulenov, the combine director, reported. "We obtain new output from production waste products. Complete use of lead raw materials has reached 96 percent, and in overall output the percentage of side-recovery products already constitutes more than half."

The combine collective is confidently completing the third year of the five-year plan. Nonferrous metals valued at hundreds of thousands of rubles have been produced in excess of plan. Metallurgists have saved hundreds of tons of fuel, electrical energy, and various materials. And, of particular importance, there has been an improvement in the quality of the output exported to dozens of countries around the world.

The combine managers justifiably feel that the components of success include constant concern for people. The metallurgists have their own recreational centers, including ones on the Black Sea coast of the Caucasus, a Young Pioneers camp, a clinic, and a dispensary. A large subsidiary farm that is under construction is already providing milk, meat, and vegetables for the plant's dining halls.

S. Takezhanov, KaSSR minister of nonferrous metallurgy, states:

"The experience of the Ust-Kamenogorsk Lead-Zinc Combine in making complete use of ore raw materials was approved at one time by the CPSU Central Committee. It is gratifying that the collective has not been marking time. The plant has begun producing greater amounts of rare metals -- indium, tallium, selenium, tellurium, and bismuth. This year we assimilated the technology for eliminating chlorine in the commercial product and have assured the complete purification of the technological and ventilation gases in lead production. The combine covers more than half its need for thermal energy by recycling the heat from the metallurgical process."

That path has also been chosen by many other enterprises in the branch. The Ust-Kamenogorsk Titanium-Magnesium Combine at this time produces nine types of output, including six from waste products. At the Irtysh Chemical-Metallurgical Plant, all rare and rare-earth elements contained in the raw materials are extracted and brought to the point of finished output. The Dzhezkazgan Mining and Metallurgical Combine has achieved the planned rate for copper extraction -- 98 percent. There have also been interesting experiments at the Pavlodar Aluminum Plant.

The year's pledge for producing nonferrous metals and alumina in excess of assignment has been considerably overfulfilled, and since the beginning of the five-year plan the workers in the branch have exceeded the plan for metals, alloys, salts, acids, and other types of output by tens of millions of rubles. The growth has been achieved by increasing labor productivity. Simply by involving the tailings in circulation, within ten months tens of thousands of tons of metals were produced.

It is important to note that this success is closely linked with the reinforcement of the ore base. In recent years, machinery has been put into operation at the Zhezkent, Zhayrem, Karagayly, and Akchatau mining and concentration combines, and a new concentrating factory has been put into operation at the East Kazakhstan Copper and Chemicals Combine. Reprocessing of tailings has begun at the Leninogorsk Zinc Plant.

Nevertheless the development of the ore base continues to lag behind today's requirements. New deposits -- the Orlovskoye, Nikolayevskoye, Kamyshinskoye, and Krasnooktyabrskoye deposits -- are being poorly assimilated. One deposit that requires special attention is the Aktogayskoye deposit, which has been called upon to provide the raw materials for the Balkhash Mining and Metallurgical Combine. It will be necessary to intensify the assimilation of new ore regions in the operational zone of the Dzhezkazgan complex. Meanwhile, the deadlines for activating projects have not been met in a few places.

Our chief contractor is KaSSR Mintyazhstroy [Ministry of Heavy Industry Facility Construction]. And it is that ministry's subdivisions which have not been using the allocated funds. The construction organizations that were created at one time to meet the needs of our branch are occupied today with other projects. True, the metallurgists do a lot of construction through their own efforts, but in this regard they are restrained by interruptions in the supply of materials and equipment.

We would like to return to the complete use of mineral raw materials. This is a major problem for the national economy! Its resolution will strengthen the ore base, will release a considerable amount of fertile land that is currently occupied by tailings, and will improve the environment. The success here is linked with the switch to so-called autogenous processes for smelting concentrates. The introduction of these processes requires the unification of the efforts of scientific-research institutes, enterprises, and ministries and departments. Thus far, one cannot sense any strong cohesion in this area, especially in the actions of the design institutes. Judge for yourselves: in a number of designs, proper attention is not given to the complete use of raw materials. In the design assignment for the Leninogorsk Metals Combine, problems in developing a technology with small amounts of waste products have not been resolved.

And one last word. Our branch has at its disposal considerable resources for increasing the production of consumer goods. Almost all the enterprises are engaged in this, and the production of more than a hundred articles -- dyes, colored glass, flints for lighters, oxides, souvenirs from stone, and so on, has been assimilated. During the first ten months, commodities with a total

value of 10.5 million rubles were sold. But additional resources exist. That same Ust-Kamenogorsk Lead-Zinc Combine, by using production waste products, has assimilated the production of zinc oxides and other dyes and could produce even more. But an obstacle has arisen: in order to produce paint that is ready for use, it is necessary to have "dry white lead" that is also produced there. But for some reason no funds are being allocated to the combine for that purpose. It would seem to be a simple question, but the correspondence has been dragging on for a long time. It would seem that it is necessary to give the enterprise the right to use its waste products at its own discretion in order to produce consumer goods and to sell the excess in a planned procedure.

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# EFFORTS OF SCIENTISTS AT UST-KAMENOGORSK TITANIUM-MAGNESIUM COMBINE DESCRIBED

Moscow IZVESTIYA in Russian 6 Jun 85 p 2

[Article by M. Baybekov, director of the Ust-Kamenogorsk Titanium-Magnesium Combine, candidate of technical sciences, under the rubric "Key Task: Introduction": "Science in the Shop: Host or Guest?"; first three paragraphs are source introduction]

[Text] East Kazakhstan Oblast. The Ust-Kamenogorsk Titanium-Magnesium Combine has become a kind of testing ground for many of our country's scientific institutions. Many scientists go there not as guests, but as full-fledged hosts.

Simultaneously, people engaged in metallurgical production are also at scientific institutions. They bring up before the court of scientists the ideas that were created at the enterprise shops and defend dissertations concerning them. Today the combine has ten candidates of technical sciences working there, and several engineers are preparing to present their projects toward gaining an academic degree.

The author of the following article -- Murat Kazmukhametovich Baybekov -- also has an academic degree. In addition he is a winner of the KaSSR State Prize, and an honored inventor in the republic.

Twenty years ago a State Commission accepted the first phase of the Ust-Kamenogorsk Titanium-Magnesium Combine. The plan included all the achievements of technical thought of that time. However, while construction was under way, the worldwide and domestic practice of producing titanium moved ahead and individual innovations failed to find their way into the combine's shops. Therefore, immediately after the startup, the collective was faced by the question: either continue to operate at the level of yesterday's achievements so that, years later, one could carry out fundamental remodeling, or begin on the very first day to engage in the intensive raising of the technical level of production. We chose the second path.

The combine established creative ties with dozens of organizations. They included branch planning and research institutes, subdivisions of the USSR Academy of Sciences and of several republic academies, and higher educational institutions.

But coming to an understanding of the union with science is not yet everything. Any idea has to be checked not only "in the test tube." Therefore an experimental shop was created at the combine. Judging on the basis of its structure and equipment, it is on a par with the enterprise's basic shops. More than 200 persons work there.

Having such a powerful and well-equipped testing ground, the combine's scientists and metallurgists have considerably shortened the periods of time required to introduce many of the projects that have been developed. And this has substantially raised the technical level not only of the Ust-Kamenogorsk Titanium-Magnesium Combine, but of the entire subsector. In the developmental process, in addition to new types of equipment, unusual materials are also created sometimes. As one of the most recent examples I can mention a synthetic cast refractory material, "ftorflogolit," which was created and recently assimilated in cooperation with the UkSSR Academy of Sciences Institute of Casting Problems, and the All-Union Aluminum-Magnesium Institute. This untraditional and very strong material, like every other progressive innovation, had an immediate effect both upon the combine's economic indicators and upon the state of the environment. But this is only one innovation, and there are dozens of them in the shops. The union of production and science has helped to raise substantially the technical level of the comparatively young enterprise. Today our titanium sponge and refined magnesium occupy, with regard to quality, first place in the country and are on a par with the best foreign output.

Thanks to the improvement of the technical-economic indicators of the combine and other enterprises in the subsector, it has become possible to reduce considerably the price of titanium, and this has made it possible to use it more broadly in our country's national economy. As a structural material, titanium has become a serious competitor to many metals.

The new technologies developed with the aid of scientists have made it possible to use raw materials much more completely. At the present time, we extract from what used to go into the tailings a rather large number of by-products: vanadium pentoxide, scandium oxide, hydrochloric acid, and other components. And the amount of vanadium pentoxide that the combine extracts is several times more than the amount produced by all other enterprises in the subsector, taken together. There has been a sharp reduction in the effluent into the environment. We currently produce more than twice the output than we did during the combine's first years of operation, but the emission of gaseous waste products has been reduced to one-tenth of the planned norms; liquid waste products, to one-eleventh; and solid, one-half.

Let us now compute what has been provided by the cooperation between production and science. During the past 20 years 12 million rubles have been expended to carry out research and experimental-design operations. But the economic effect is computed at 22 million. Introducing new techniques and technologies, with the redesigning of the shops that this naturally entailed, cost less than 20 percent of the initial estimated cost of the combine. But the production of commercial output increased by a factor of 2.27 as compared with the planned output. That made it possible to save the national economy

tens of millions of rubles of capital investments. That is what science can produce if it is in the shop as the host rather than a guest.

However, I am far from stating that scientists' contributions, if only those to the work of our titanium-magnesium subsector, have been exhaustive. It is time to switch from the resolution of local questions to basic problems. I have in mind the involvement of new types of magnesium raw materials in production and the development of methods of preparing them for electrolysis; the continuous method of obtaining titanium; plasma technology; and a number of others.

But in order to do this it is necessary to overcome one of the most serious obstacles of our time -- interdepartmental bureaucratism. In fact, scientists and industrial workers sometimes grope for the thread through which it is possible to gain a tremendous economic benefit, but that thread, it turns out, leads to another department. Instead of allowing that effort to join in -- after all, it's the same national economy! -- the related ministry, on the contrary, does everything possible to break that strategically important thread. There has been a tremendous number of examples of this. Beginning with the many years of correspondence concerning the creation of machine tools for the mechanized dressing of titanium castings (dozens of production entities suffer from a lack of them) and ending with problems of the raw-materials base for the domestic magnesium industry.

Whereas the red tape regarding the machine tools has been restraining the mechanization of individual shops, the questions of raw materials are of great importance for the entire economy. For many years the magnesium industry has used potassium carnallite. Producing magnesium from it is cumbersome and requires complicated preparation for electrolysis. In addition, the metal yield is low.

Meanwhile, the brine from salt lakes, natural deposits of bischofite, and certain other types of raw materials are good materials for obtaining magnesium. Our country has all these materials at its disposal in unlimited quantities. Moreover, they are frequently located close to operating enterprises. Today the initial raw materials are brought to our combine from the Urals. It is not just the transportation expenses that are large. The freight distance also has an effect upon the rhythm of the shipments. And yet Lake Kuchukskoye is located just 500 kilometers from Ust-Kamenogorsk, in Altay Kray. From the brine taken from that lake, the Kuchukskiy Sulfate Combine of USSR Minkhimprom [Ministry of the Chemical Industry] extracts basically a single component. Everything else is thrown back into the lake. But this "everything else" is the raw material for the magnesium industry.

When our enterprise was being designed, provision was made for the opportunity to use the lake's brine as magnesium raw material. For that purpose, experimental projects were begun as early as the 1960's. Semi-industrial units were built, and a series of tests were carried out, in the course of which it was confirmed that, in principle, it is possible to obtain magnesium from brine. But USSR Minkhimprom lost interest in that work. The experimental unit in Kuchuk was dismantled and the job was terminated before it was half-done.

We are raising this question again today. The combine's proposals have found support at the republic and union ministries of nonferrous metallurgy. The point is is that an extremely tense situation has developed currently with carnallite. Failing to receive any development over the entire current five-year plan, the enterprises of Uralkaliya, of the USSR Ministry of Mineral Fertilizer Production, have lagged behind the combine's demands. New buildings for magnesium production, for the construction of which large amounts of money have been expended, have remained without raw materials. All things considered, the same situation will prevail during the 12th Five-Year Plan as well. Therefore, completing the tests that have been begun by science and practice regarding the use of a new type of magnesium raw material is one of the most vitally important questions today. However, the metallurgists' proposals, once again, are not finding any support either at Minkhimprom or Ministry of Mineral Fertilizer Production.

One of the important problems for our country's nonferrous metallurgy is increasing the complete use of raw materials. We produce as by-products a large number of valuable products. But we could produce much more. In order to do that, on the basis of a proposal made by the enterprise's specialists and the scientists, a waste-products reprocessing shop was provided in the plan for the expansion of the combine. The shop, which will cost 9 million rubles, can produce by-products with a total value of almost 6 million rubles a year. However, ten years have passed, and the researchers' proposals have not been implemented. Nor has construction of the shop been stipulated during the 12th Five-Year Plan. Consequently, instead of giving the country products that are very necessary, and sharply reducing, by means of the complete use of raw materials, the damage that is being done to the environment, we must dump all this on the tailings.

At the April 1985 Plenum of the CPSU Central Committee it was noted that the factor that is being brought into the foreground today as the chief strategic lever for the intensification of the national economy is the basic acceleration of scientific-technical progress. Never before has the question been posed in such a pointed or fundamental manner. Consequently, the obstacles that are standing in the way of this acceleration should be removed just as decisively, on the one hand, by giving the collective a self-interest in the rapid introduction of everything that is progressive and, on the other hand, by removing the blessings and honors from all those who cannot use, or who do not want to use, scientific-technical innovations.

And it was not accidental when I mentioned self-interest. At the present time, for example, when summing up the results of the socialist competition, frequently no consideration is given to the highest rates of titanium extraction, the complete use of raw materials, the specific expenditure of materials and energy resources, or the quality grading of the output. And yet, in the well-known decree of the CPSU Central Committee concerning the improvement of socialist competition, it is proposed that special attention be devoted to fulfilling specific qualitative indicators and to assignments on the development of science and technology. However, USSR Mintsvetmet [Ministry of Nonferrous Metals] does not always take this into consideration when summing up the results of work performed by enterprises. Thus, there no

longer exists any incentive to improve production constantly on the basis of scientific-technical progress.

In order to eliminate the formal approach when summing up the results of the competition, and, consequently, to determine objectively the rates of movement along the path of technical progress, it is high time, from our point of view, to switch to a point system for evaluating results of work performed by a particular collective. In other words, to make, for example, a list of the basic technical-economic indicators for the subsector and, in figures, to evaluate their importance. Then it will be possible objectively to isolate the actual leader in the competition, who, in order to achieve the best results, orients himself to technical progress. And it will be immediately obvious where science in the shop is a full-fledged host, and where it is an unwanted guest.

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KIROVGRAD COPPER-SMELTING COMBINE INCREASES PRODUCTION BY USING TAILINGS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 15 Aug 85 p 1

[Article by SOTSIALISTICHESKAYA INDUSTRIYA correspondent A. Maltsev: "Stakhanov's Heirs: The Collective at the Kirovgrad Copper-Smelting Combine Has Fulfilled the Five-Year Plan Ahead of Schedule"]

[Text] Kirovgrad. The collective at the Order of the Red Banner of Labor Kirovgrad Metallurgical Combine, the country's largest supplier of blister copper, is greeting the fiftieth anniversary of the Stakhanovite movement with shock-labor methods. The five-year plan for production volume was completed here 20 days ahead of schedule.

That day was brought closer by the intense labor of the workers in all production sectors. As early as June, reports began coming in concerning the fulfillment of the five-year plan by individual collectives. The first news of the labor victory arrived from the rare-metals shop. There, on 9 June, foreman A. Royev's shift produced the last output to be counted on the five-year plan. A month later that goal was reached by V. Rzhannikov's shift, and on 10 July the fulfillment of the five-year assignment for commercial output was reported by a collective in basic production -- the metallurgical shop where a worker who especially distinguished himself was senior converter operator V. Mochalov, who accepted the relay baton from the famous metallurgist and Stakhanovite worker of the wartime and first postwar years, Hero of Socialist Labor P. Burkov.

The fulfillment of the planned assignment considerably ahead of schedule was the result of the constant creative search carried out by the collective and the remodeling of the existing production that is being done at the enterprise. Only one of the recent innovations -- the heated-air blasting, which, incidentally, was employed for the first time in the sector -- increased the furnace productivity by 20 percent and made it possible to save a large amount of coke. The redesigning is being carried out by the combine's own forces without stopping production.

"Our backlog has hundreds of projects that were developed by engineers, technicians, and workers," L. Chernyy, the combine's party committee secretary, says. "The implementation of those projects will make it possible to produce more output with even smaller expenditures. People have acquired a

taste for the new, and have seen with their own eyes the benefit from the introduction of technical innovations."

The course taken, which is aimed at introducing technology with no waste products, as well as introducing resource-saving methods of production, has been yielding rather good results. The enterprise where the first Soviet copper was produced is currently producing the country's cheapest metal. The dynamics of the increase in the economical nature of production can be discerned in the following example. When, 16 years ago, on the initiative of converter operator P. Burkov, the metallurgists pledged to save one ruble per worker for the entire shift, that was done with a large amount of labor. Currently, however, in certain shifts of converter operators, each person accounts for an average savings of as much as 25 rubles. The collective is already overfulfilling its pledge to operate three days a year on electrical energy that has been saved, and the increase in labor productivity is almost quadrupling the planned increase.

The metallurgists are preparing a base for further work, which is even more highly productive and economical. They have a precise plan for remodeling and introducing technological innovations at the combine; this plan was developed in cooperation with specialists at the Unipromed sector institute. Implementation of the plan will make it possible, in the very same production areas, to increase copper production by almost one-third, and to produce thousands of additional tons of zinc and tin which are currently being lost in the tailings. It is planned to do all of this with small expenditures which will pay for themselves in less than two years. The collective is taking onto its shoulders a large share of the remodeling operations.

Recently the collective at the combine has received dozens of congratulations from nonferrous metallurgy enterprises in the country. The coworkers in the sector express the hope that the people at Kirovgrad with whom they are trying to keep up will continue to develop the glorious traditions of the Stakhanovite movement.

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# DELAYS INTRODUCING WASTE RECOVERY TECHNOLOGY AT SODA PLANTS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 17 Jan 87 p 2

[Article by A. Yakovlev: "At the White Sea: Why a Waste-Free Soda Production Process is Being Introduced Slowly"]

[Text] Sterlitamak, Moscow--At Sterlitamak I was greeted with an unexpected proposal:

"Would you like to tour the 'White Sea'?"

The car headed toward the city's southern outskirts and drove along narrow dams separating soda plant slurry settling tanks ("white sea" in industry jargon).

Construction of the soda plant on the banks of the Belaya River, an abundant tributary of the Kama, began during the war years. Sterlitamak was not selected accidentally. To obtain soda, sources of two types of raw materials, common salt and lime, must be nearby. They fortunately turned out to be in the vicinity. This also predetermined the technology for the future plant -- the ammonium method, relatively simple and inexpensive, well developed in many countries, including ours at Berezniki and in the Ukraine.

However, with all its pluses, the ammonium method has a serious minus: 10 cubic meters of saline wastes and 250 kilograms of solid slurry are formed for each ton of product. The more production expanded at Sterlitamak, the more wastes were created.

It was up to chemists to study waste water purification. Man-made lakes were developed in which a large amount of harmful impurities are settled out. Purified water continues to be drained into the river, but now under the supervision of water protection authorities, in a strictly limited amount, and only once a year, during the floods. The slurry left at the bottom gradually fills the lake, and the day comes when the drain pipes are taken to a new "white sea."

Today almost 400 hectares taken from the Krasnoye Znamya Kolkhoz and other farms are filled with wastes. Several million tons of slurry have accumulated. What next? I took this question to the general director of the Sterlitamak Soda Association, A. Shatov.

Despite my expectations, he was optimistic. I knew that they were starting to process slurries little by little: in the past year 16,000 tons of binders, which the construction materials plant used to make silica brick, were produced. They supplied Ufa with filler for asphalt concrete, gas and oil men with well packing, and agricultural builders with gas concrete.

Design of the entire complex, the first phase of which was to have been built in this five-year plan, is now being completed. Every year 130,000 tons of slurry will be processed there; all of it when the second phase is started up. In the future, therefore, there will be no need to ask for land for new "white seas."

The director does not say that the new product is still basically unprofitable. Let's say that the lime used today in production of silica brick costs about 15 rubles per ton. And belite binders which the first phase of the complex will produce are almost twice as expensive. Who goes after losses?

"That's not the main thing; we'll solve that," A. Shatov assures me. "Today we have a technology which will not only recover construction costs, but will lower the net cost of the soda itself. If only they would allot capital investments and give us a high-powered contractor, Sterlitamak would have the world's first wasteless soda! And not just soda, but zeolite, plus caustic, plus cement!"

Does this mean that we can consider the problem solved? Do they share the Sterlitamak director's optimism at Soyuzneorganika All-Union Production Association, to which soda enterprises are subordinate?

"You can't cheat on work," M. Chistyakov, head of the VPO [All-Union Production Association] began with his favorite introduction. "You can't make something out of nothing for free. As soda production grew, the ecological situation became more and more serious. Therefore, without waiting for life to push us to the wall, when the very existence of soda plants would become problematic, we brought in science led by the Kharkov Karbonat NPO [Scientific Production Association]. Our combined efforts resulted in development of a technology for complete waste processing.

"Recovery of liquid effluents is now being studied at the Slavyansk and Lisichansk Plants. In this five-year plan, dumping into the river will stop completely, and it has been cut in half already. Sterlitamak is also studying slurry. Now the matter depends on allocation of resources, on builders, and on Gosplan. Life has pressed the soda producers, but, clearly not the planning agencies yet."

We don't have to look far for examples -- the soda plant in Berezniki, a sister to the one at Sterlitamak, is second in the country in capacity, but still does not recover wastes and, at least in the current five-year plan, does not intend to study this problem. Waste waters are dumped into the Kama year round. And together with wastes, thousands of tons of valuable raw material are irretrievably lost.

Problems of introducing the resource-saving and low-waste technology must obviously be solved not only on the level of the plant, all-union production association, or even one ministry. A special government plan is needed, centrally supported with the necessary resources and taking into account the interests of both those who make products from wastes and those of users. The main thing is that it take into account the interests of nature preservation. And, of course, resources for this must be specially allocated for a particular purpose, so that they cannot be spent on anything else.

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# REDUCTION OF LISAKOVSK IRON ORE CONCENTRATES IN DENSE MOVING BED

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 12, Dec 86 (manuscript received 10 Jul 85) pp 10-13

[Article by A.B. Talzhanov, Ye.V. Maksimov, B.S. Fialkov, I.I. Perveyeva and Sh.K. Kopbasov, Chemistry and Metallurgy Institute, TsKO [expansion unknown], KaSSR Academy of Sciences, Karaganda]

[Abstract] An experimental study was made concerning preliminary reduction of Lisakovsk iron ore concentrates by means of a gaseous deoxidizer in a moving bed. Such a bed of gravity-magnetic concentrate containing 49.8% Fe total and 1.75% FeO of the 0.05-0.63 mm grain size fraction was treated in a processor at temperatures of 823-1373 K, at rates of 450-4170 kg/h per 1 $m^2$ of bottom area using 1.0-3.5 $m^3$ of hydrogen per 1 kg of iron. An analysis of the process revealed two stages of reduction and attendant heat transfer, namley heating with partial reduction in the upper part of the bed by counter-flowing gas and 90-98% complete reduction in the lower part of the bed by circulating gas. A comparative evaluation of the product in a moving bed and in stationary bed respectively, based on microstructural examination for the depth of ore grain metallization as well as chemical analysis, indicates that it is feasible to make reduction in a dense moving bed more than 95% efficient. This requires allowing the ore particles to dwell sufficiently long in the circulation zone with periodically repeated shake action, at temperatures about 1073 K with a gas consumption of typically 3.89 $m^3/h$. References 3: all Russian.

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# PRODUCT QUALITY IS THE BASIS FOR ACCELERATION

Moscow MASHINOSTROITEL in Russian No 12, Dec 86 p 1

[Unsigned article]

[Text] The path to acceleration of socio-economic development and the achievement of a new state of excellence in Soviet society outlined by the 27th Congress of the CPSU is steadily materializing. On the Party's initiative fundamental changes are being wrought in all spheres of government and social life; important scientific, technical, and socioeconomic changes are being carried out; socialist production relations, administrative systems, and management methods are being perfected.

The fundamental point of the Party's economic strategy is the basic acceleration of scientific and technical progress, The problem of achieving an intensified increase in the technical level and quality of industrial output is put at the center of economic policy and practical work. Many enterprises are accomplishing significant work in this direction, achieving superior final results. In setting up the output of a new heavy-duty tractor, the Leningrad Kirovskiy Zavod Production Association (PO), along with the Yaroslavl Autodiesel PO and other suppliers, have developed and are fulfilling general obligations to improve machine quality. The collective of the Moscow Frezer Cutting Tool Plant imeni M.I. Kalinin has achieved the output of high quality goods. Much is being done at the tractor-building Minsk Tractor Plant imeni V.I. Lenin PO to increase the quality of wheeled tractors and to extend their operating life. High quality distinguishes the automatic lines produced by the Moscow Machine Tool Plant imeni S. Ordzhonikidze, the equipment for continuous cast of steel produced by the Uralmash PO, and the products of other enterprises of the country.

The Ministry of Instrument Making, Automation Equipiment, and Control Systems has approved a comprehensive program "Quality" for this branch of industry which provides for specific assignments for increasing the relative share of output in the highest quality categories, reducing their material content, adn ceasing production of obsolete goods. Without high product quality it is impossible to achieve acceleration of scientific and technical progress and to successfully solve key production and social problems.

General Secretary of the CPSU Central Committee Comrade M.S. Gorbachev, in a meeting with the workers of the city of Tolyatti, stressed that it is necessary to affirm the advantages of socialism not only by the political system and social benefits, but by economic results, progressive technology, and high quality goods.

The basic directions of the economic and social development of the USSR for the years 1986-1990 and for the period to the year 2000 anticipate increasing the share of industrial products in the highest quality category by 1.9 to 2.1 times; increasing the reliability and operating life of equipment; essentially completing the introduction of complex quality control systems; accelerating the revision of standards and product specifications, aligning them with the highest international standards; improving the metrological service of the national economy; raising the level of work in certification of industrial products in order to provide an objective evaluation of product quality.

The decree of the CPSU Central Committee and the USSR Council of Ministers entitled "On Measures for Radically Increasing Product Quality" stresses that under current conditions a radical increase in product quality is one of the key economic and political tasks in following the course set by the 27th Party Congress for acceleration of the country's socioeconomic development, and the most important factor in intensifying the economy in order to most completely satisfy the growing needs of the national economy and population.

In recent years definite work has been done in the national economy to increase the technical level and quality of output and work performed, but the results achieved have not measured up to the tasks. The aforementioned decree outlined a set of organizational, economic, and legal measures aimed at increasing technical level and quality of the output produced.

The scope of the tasks in strengthening the role and responsibility of development engineers for assuring a high level and quality of output has been defined. It has been established that a development engineer takes upon himself guaranteed obligations to the manufacturer for the quality of the technical documentation being handed over to production and that the article developed will correspond to the technical task.



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